

MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

VOL. LXII. SUPPLEMENTARY NUMBER, 1902. No. 9

On the General Solution of Laplace's Equation and the Equation of Wave Motions, and on an undulatory explanation of Gravity. By E. T. Whittaker, M.A.

I. Laplace's Equation.

The first part of this communication is concerned with the well-known equation which was first introduced in Laplace's memoir on the ring of *Saturn*, and which is now of such importance in mathematical physics. The general solution has not hitherto been found in a finite form: we shall show that it is given in a finite form by the following result:

The general solution of Laplace's equation

$$\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} = 0$$

is
$$V = \int_0^{2\pi} f(x \cos v + y \sin v + iz, v) dv,$$

where f is an arbitrary function of the two arguments $x \cos v + y \sin v + iz$ and v .

To establish this, let $V(x, y, z)$ be any solution (single-valued or many-valued) of Laplace's equation. Since the differential equation is unaffected by a change of origin, and since any function of the two arguments $(x \cos v + y \sin v + iz)$ and v is also a function of the arguments $(x' \cos v + y' \sin v + iz')$ and v , where (x', y', z') are the coordinates of the point (x, y, z) referred to parallel axes through any other origin, it clearly will not affect the generality of the proof if any particular point be taken as origin; we shall therefore suppose that the origin is taken at some point at which some branch of the function $V(x, y, z)$ is

regular, so that this branch of $V(x, y, z)$ can be expanded in the neighbourhood of the origin in the form

$$V(x, y, z) = a_0 + a_1x + b_1y + c_1z + a_2x^2 + b_2y^2 + c_2z^2 + d_2yz + e_2zx \\ + f_2xy + a_3x^3 + \dots,$$

where $a_0, a_1, b_1, \dots$ are constants, and the series is absolutely and uniformly convergent for a domain of finite extent.

Substituting this expansion in Laplace's equation, and equating to zero the coefficients of the various powers of x, y , and z , we obtain an infinite number of linear relations between the constants $a_0, a_1, b_1, \dots$. There are $\frac{1}{2}n(n-1)$ of these relations between the $\frac{1}{2}(n+1)(n+2)$ coefficients of the terms of any degree n in the expansion of V ; so that only $\{\frac{1}{2}(n+1)(n+2) - \frac{1}{2}n(n-1)\}$ or $(2n+1)$ of the coefficients of terms of degree n in the expansion of V are really independent.

Moreover, it is clear that the terms of degree n in V must satisfy Laplace's equation, quite independently of the terms of other degrees; and therefore the terms of degree n in V must be a linear combination of $(2n+1)$ linearly independent solutions of degree n .

To find these solutions, consider the expansion of the quantity $(x \cos v + y \sin v + iz)^n$ as a sum of sines and cosines of multiples of v , in the form

$$(x \cos v + y \sin v + iz)^n = g_0(x, y, z) + g_1(x, y, z) \cos v \\ + g_2(x, y, z) \cos 2v + \dots + g_n(x, y, z) \cos nv \\ + h_1(x, y, z) \sin v + h_2(x, y, z) \sin 2v + \dots \\ + h_n(x, y, z) \sin nv.$$

The $(2n+1)$ quantities $g(x, y, z)$ and $h(x, y, z)$ are clearly linearly independent homogeneous polynomials of degree n in x, y, z ; and each of them must satisfy Laplace's equation, since $(x \cos v + y \sin v + iz)^n$ does so. These are therefore the $(2n+1)$ independent solutions of Laplace's equation, of degree n .

Now since by Fourier's theorem we have the relations

$$g_m(x, y, z) = \frac{1}{\pi} \int_0^{2\pi} (x \cos v + y \sin v + iz)^n \cos mv \, dv \\ h_m(x, y, z) = \frac{1}{\pi} \int_0^{2\pi} (x \cos v + y \sin v + iz)^n \sin mv \, dv,$$

it follows that each of these $(2n+1)$ solutions can be expressed in the form

$$\int_0^{2\pi} f(x \cos v + y \sin v + iz, v) \, dv,$$

and therefore any linear combination of these $(2n+1)$ solutions can be expressed in this form. That is, the terms of degree n in $V(x, y, z)$ can be expressed in this form, where n is any positive integer; and therefore $V(x, y, z)$ (which was taken to be any solution of Laplace's equation) is itself of this form; which establishes the theorem.

2. *The Partial Differential Equation of Wave-Motions.*

It can in the same way be shown that the *general solution of the general differential equation of wave-motions, namely*

$$\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} = k^2 \frac{\partial^2 V}{\partial t^2}$$

is

$$V = \int_0^\pi \int_0^{2\pi} f(x \sin v \cos \psi + y \sin v \sin \psi + z \cos v + kt, v, \psi) dv d\psi,$$

where *f* is an arbitrary function of the three arguments

$$x \sin v \cos \psi + y \sin v \sin \psi + z \cos v + kt, v, \text{ and } \psi.$$

From this result it follows, by the application of Fourier's double-integral theorem, that *any solution of the equation*

$$\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} = k^2 \frac{\partial^2 V}{\partial t^2}$$

can be analysed into simple plane waves.

3. *An Undulatory Explanation of Gravity.*

In connection with the last property it can be shown that *distributions of simple waves exist such that, although each individual wave is periodic with respect to the time, yet the total disturbance at any point does not vary with the time.* The simplest example of this is the following. Suppose a particle to be emitting spherical waves, such that the disturbance due to the waves

whose wave-length lies between $\frac{2\pi}{\mu}$ and $\frac{2\pi}{\mu + d\mu}$ is

$$\frac{2d\mu}{\pi\mu} \cdot \frac{\sin \mu(Vt-r)}{r},$$

where *V* is the velocity of propagation of the waves. Then after the waves have reached the point *r*, so that $(Vt-r)$ is positive, the total disturbance there (due to the sum of all the waves) is

$$\frac{2}{\pi r} \int_0^\infty \frac{\sin \mu(Vt-r)}{\mu} d\mu$$

or
$$\frac{2}{\pi r} \int_0^\infty \frac{\sin y}{y} dy, \quad \text{where } \mu(Vt-r) = y,$$

or
$$\frac{1}{r},$$

i.e. the disturbance is independent of the time and is everywhere proportional to the gravitational potential of the particle. It is easily seen that *for all such distributions the total disturbance can always be represented by a solution of Laplace's equation.*

Since Laplace's equation is the equation satisfied by the components of any field of force due to gravitating bodies, this result suggests an explanation of the propagation of gravitation. For we thus see that it is possible to analyse the field of force due to a gravitating body, by a "spectrum analysis" as it were, into an infinite number of constituent fields; and although the whole field of force does not vary with the time, yet each of the constituent fields is of an undulatory character, *i.e.* the disturbance at any point reproduces itself after the lapse of any time at another point whose distance is proportional to the elapsed time. But this result assimilates the propagation of gravitation to that of light; for the undulatory phenomena just described, in which the varying vector is a gravitational force perpendicular to the wave-front, may be compared with those made familiar by the electromagnetic theory of light, in which the varying vectors consist of electric and magnetic forces parallel to the wave-front. The waves are in other respects of the same type in the two cases, and it seems probable that an identical property of the medium ensures their transmission through space. This undulatory theory of gravity would require that gravity should be propagated with a finite velocity, which, however, need not be the same as that of light, and may be enormously greater.

Of course this investigation does not explain the *cause* of gravity; all that is done is to show that the propagation across space of forces which vary as the inverse square of the distance does not require for its explanation any other property of the medium than one which has long been known and accepted.

On the Mean Distance of a Planet, as a Function of Three Heliocentric Distances and the Observed Times. By Shin Hirayama.

§ 1. Let r_1, r_2, r_3 be three heliocentric distances of a planet;
 t_1, t_2, t_3 the corresponding observed times;
 a the mean distance.

The radius vector of a planet must satisfy the differential equation

$$\frac{d^2s}{dt^2} - \frac{2}{\sqrt{s}} + \frac{2}{a} = 0,$$

putting $r^2 = s$.

If we let

$$\theta_1 = k(t_3 - t_2), \theta_2 = k(t_3 - t_1), \theta_3 = k(t_2 - t_1), \log k = 8.235581 - 10,$$

and express the value r^2 in terms of t by expansion into series, we have

$$s = r^2 = a_0 + a_1 t + a_2 t^2 + a_3 t^3 + a_4 t^4,$$

where a_0, a_1, a_2, a_3, a_4 are five constants independent of time.

Now, for $t = -\theta_3$

$$s = s_{11}, \quad \frac{d^2 s}{dt^2} = \frac{2}{\sqrt{s_1}} - \frac{2}{a},$$

for $t = 0$

$$s = s_{21}, \quad \frac{d^2 s_2}{dt^2} = \frac{2}{\sqrt{s_2}} - \frac{2}{a},$$

for $t = \theta_1$

$$s = s_{31}, \quad \frac{d^2 s_3}{dt^2} = \frac{2}{\sqrt{s_3}} - \frac{2}{a}.$$

Hence

$$s_1 = a_0 - \theta_3 a_1 + \theta_3^2 a_2 - \theta_3^3 a_3 + \theta_3^4 a_4,$$

$$s_2 = a_0,$$

$$s_3 = a_0 + \theta_1 a_1 + \theta_1^2 a_2 + \theta_1^3 a_3 + \theta_1^4 a_4,$$

$$\frac{2}{\sqrt{s_1}} - \frac{2}{a} = 2a_2 - 6\theta_3 a_3 + 12\theta_3^2 a_4,$$

$$\frac{2}{\sqrt{s_2}} - \frac{2}{a} = 2a_2,$$

$$\frac{2}{\sqrt{s_3}} - \frac{2}{a} = 2a_2 + 6\theta_1 a_3 + 12\theta_1^2 a_4.$$

Eliminating the five constants a_0, a_1, a_2, a_3, a_4 from these six equations, we get a single equation of the form

$$\left. \begin{aligned} \frac{\theta_1 \theta_2 \theta_3}{a} &= 2 \left(\frac{\theta_1 \mu_1}{r_1} + \frac{\theta_2 \mu_2}{r_2} + \frac{\theta_3 \mu_3}{r_3} \right) = (\theta_1 r_1^2 - \theta_2 r_2^2 + \theta_3 r_3^2) \\ \text{where} \quad \mu_1 &= \frac{1}{12} (\theta_2 \theta_3 - \theta_1^2), \quad \mu_2 = \frac{1}{12} (\theta_1 \theta_3 + \theta_2^2), \quad \mu_3 = \frac{1}{12} (\theta_1 \theta_2 - \theta_3^2) \end{aligned} \right\} (1)$$

This is the required equation. A less exact formula is given by Radau in *Bulletin Astronomique*, tome ii. p. 11.

§ 2. For the purpose of testing the above expression (1) I have chosen the *Ceres* example treated by Gauss, Oppolzer, and Gibbs, the interval of extreme observations being about 260 days.

$$\log \theta_1 = 0.335852 \quad \log \mu_1 = 9.669211 \quad \log r_1 = 0.428279$$

$$\log \theta_2 = 0.650362 \quad \log \mu_2 = 0.318372 \quad \log r_2 = 0.413281$$

$$\log \theta_3 = 0.362407 \quad \log \mu_3 = 9.562392 \quad \log r_3 = 0.406200$$

The computation by (1) gives us $\log a = 0.442438$,
while Oppolzer gives $\log a = 0.442463$.

The coincidence is fairly good, if we consider the long interval of time between two observations.

§ 3. In the special case of parabolical orbits (1) becomes

$$\theta_1 r_1^2 \left(1 - \frac{2\mu_1}{r_1^3} \right) - \theta_2 r_2^2 \left(1 + \frac{2\mu_2}{r_2^3} \right) + \theta_3 r_3^2 \left(1 - \frac{2\mu_3}{r_3^3} \right) = 0 \quad (2)$$

—a relation between three heliocentric distances and the time.

§ 4. Let E_1, E_2, E_3 be the corresponding excentric anomalies, then we have

$$(r_1 - a) \sin(E_3 - E_2) - (r_2 - a) \sin(E_3 - E_1) + (r_3 - a) \sin(E_2 - E_1) = 0,$$

while (1) may be written in the form

$$(r_1 - a) \theta_1 \left(r_1 + a + \frac{2\mu_1}{ar_1} \right) - (r_2 - a) \theta_2 \left(r_2 + a - \frac{2\mu_2}{ar_2} \right) + (r_3 - a) \theta_3 \left(r_3 + a + \frac{2\mu_3}{ar_3} \right) = 0.$$

Hence, comparing the two above equations, we see that

$$\sin(E_3 - E_2) \quad \sin(E_3 - E_1) \quad \sin(E_2 - E_1)$$

are respectively proportional to

$$\theta_1 \left(r_1 + a + \frac{2\mu_1}{ar_1} \right) \quad \theta_2 \left(r_2 + a - \frac{2\mu_2}{ar_2} \right) \quad \theta_3 \left(r_3 + a + \frac{2\mu_3}{ar_3} \right) = 0.$$

Observations of the Satellite of Neptune from Photographs taken at the Royal Observatory, Greenwich, between 1902 January 6, and April 10.

(Communicated by the Astronomer Royal.)

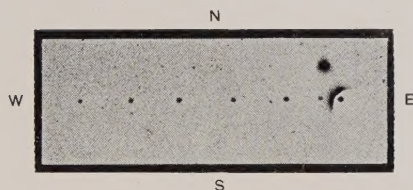
The following measures of position-angle and distance of *Neptune's* satellite were made from photographs taken with the 26-inch refractor of the Thompson equatorial. The occulting shutter was generally used, and the position of the plate adjusted so that the planet was behind the shutter while the satellite was just outside of it. By means of the shutter, which is pivoted (see *Monthly Notices*, vol. lx. No. 7), short exposures were given at intervals to the planet. Rapid plates were used, and the exposures given to the satellite were from 10^m to 30^m, generally 20^m. For the planet the short exposures, which may be taken as about $\frac{1}{10}$ ^s in duration, were given each half-minute. Thus to an exposure of 20^m on the satellite there would be thirty-nine of these short exposures on the planet.

The zero of position-angle was obtained by stopping the clock and giving a short supplementary exposure. Generally, several short exposures were given, the clock being stopped for a short time between each of them, so that each photograph contains, in

ROYAL OBSERVATORY, GREENWICH.

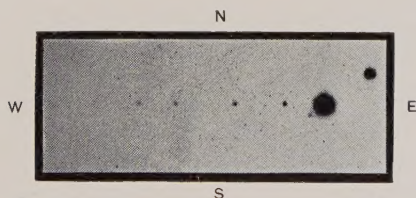
PHOTOGRAPHS OF NEPTUNE AND SATELLITE TAKEN WITH THE
THOMPSON 26-INCH PHOTOGRAPHIC REFRACTOR.

Enlarged five times. Scale 1 mm. = 6".

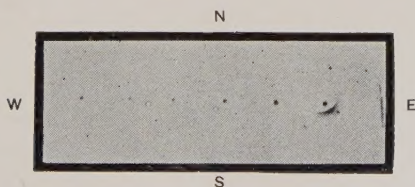


1902 February 11. *Neptune* to the right under the occulting shutter within the halo of the secondary spectrum. The satellite is to the left of *Neptune* (position-angle 277°). The other images are with five exposures of four seconds each on *Neptune* for orientation—the telescope being displaced in R.A. between the exposures.

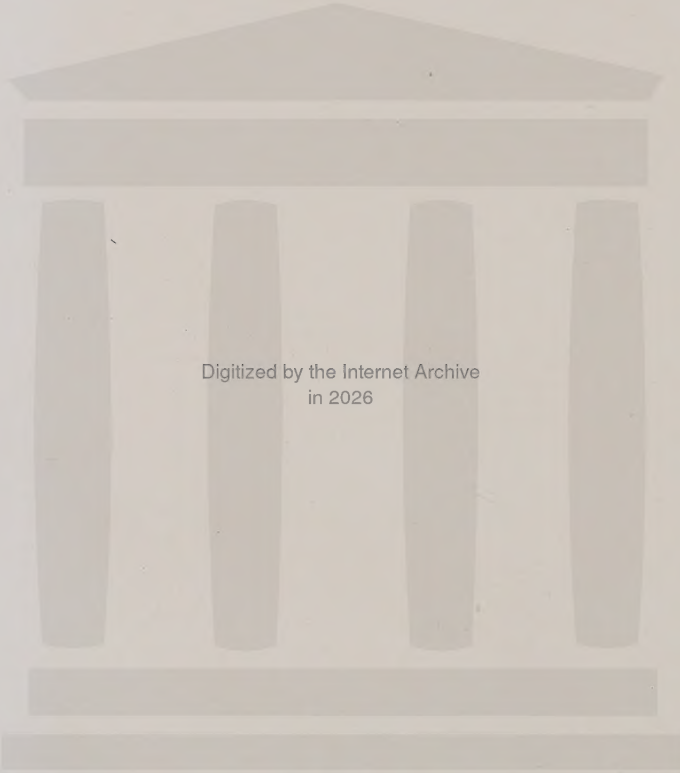
The star north-west of *Neptune* is B.D. $+22^\circ 1138$. Mag. 9.3.



1902 February 12. *Neptune* not occulted. Position-angle of satellite 235° . The other images are with exposures of 5^s, 4^s, 3^s and 5^s on *Neptune* (starting from *Neptune*).



1902 March 3. *Neptune* occulted. Position-angle of satellite 125° . The other images are with exposures of 5^s, 3^s, 2^s, 2^s and 3^s on *Neptune*. It will be seen that the image of the satellite with 20^m exposure is nearly equivalent to that of *Neptune* with 3^s exposure.



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addition to the long-exposure photograph of the satellite, a of number short-exposure images of *Neptune*.

On some of the photographs the duration of the supplementary exposures was adjusted so as to give images of the planet of the same size and density as the image of the satellite. Incidentally these determine the length of exposure given with the occulting shutter, but they are of photometric importance as showing that the satellite requires an exposure 420 times that of *Neptune* to give an equal photographic image, which, on the assumption that the photographic effect is the same for the same total amount of light, makes the satellite $6^{\text{m}}.55$ fainter than *Neptune*.

The following table gives the details of these observations :—

No of Plate.	Date.	Exposure of Satellite.	Exposure of Planet giving an Equal Image.	Ratio.	Log.	Diff. of Magnitude.
	1902.	m	s			
1106	Feb. 12	20	2.9	4.4	2.617	6.54
1115	Feb. 28	21	2.7	4.67	.669	6.67
1119	Mar. 3	20	3.0	4.00	.602	6.51
1120	Mar. 3	15	2.5	3.60	.556	6.39
		20	3.0	4.00	.602	6.51
1121	Mar. 3	20	2.5	4.80	.681	6.70
			Mean	4.20	2.621	6.55

The photographs were measured in a position micrometer in direct and reversed positions by Mr. Dyson, Mr. Davidson, and Mr. Melotte, and the results obtained by each measurer are given in order to show the degree of accordance obtained.

Corrections have not been applied separately to the distances or angles for refraction. These will in all cases be less than $0''.01$. The mean effects of refraction and aberration have, however, been included in the adopted value of the scale, as these corrections affect the mean distance of the satellite slightly, and would directly affect the mass of *Neptune* determined from these observations.

The value of r^{rev} of the screw of the measuring micrometer was determined in terms of a réseau interval of one of Gautier's réseaux used in photographic work with the Thompson and Astrographic equatorials. For photographs with the Thompson equatorial cleared of the effect of differential refraction and aberration the réseau interval = $150''.89$. The correction for differential refraction on these photographs of *Neptune* varies from $+''042$ to $+''072$, and for differential aberration from $+''006$ to $+''010$. A mean total correction of $+''07$ has been adopted, giving the réseau interval = $150''.96$, and has been used for all the photographs.

The tabular positions were computed from the data given in the *Connaissance des Temps*, based on M. H. Struve's elements, the eccentricity of the orbit being neglected owing to the uncertainty as to the present position of the periastron.

Neptune and Satellite.

Position-angle and Distance, from Photographs taken with the 26-inch Refractor.

Date, 1902.	Position-angle.					Distance.					Ex- posure.	Remarks.						
	d	h	m	s	D.	C.D.	P.M.	Mean.	Tab.	T-O.			D.	C.D.	P.M.	Mean.	Tab.	T-O.
Jan. 6	6	11	14	13	306°46'	305°53'	304°35'	305°45'	307°41'	+1°96'	12°77'	13°04'	13°04'	12°95'	12°83'	-0°12'	20	Neptune not occulted.
6	12	14	53		304°86'	303°82'	306°22'	304°97'	304°60'	-0°37'	12°65'	12°81'	12°83'	12°76'	13°09'	+0°33'	20½	
14	11	36	56		196°58'	196°14'	195°40'	196°04'	197°33'	+1°29'	11°20'	11°11'	10°98'	11°10'	11°49'	+0°39'	25	
14	12	4	48		194°45'	195°06'	194°87'	194°79'	195°65'	+0°86'	11°21'	11°44'	11°38'	11°34'	11°40'	+0°06'	20	Neptune not occulted.
24	9	7	14		289°11'	288°67'	288°27'	288°68'	290°52'	+1°84'	14°21'	14°29'	14°16'	14°22'	14°48'	+0°26'	20½	
24	9	36	34		289°60'	288°38'	287°65'	288°54'	289°46'	+0°92'	14°60'	14°76'	14°71'	14°69'	14°61'	-0°08'	20	Neptune not occulted.
28	12	7	23		58°82'	59°00'	59°50'	59°11'	59°80'	+0°69'	15°46'	15°40'	15°07'	15°31'	15°43'	+0°12'	21	
28	12	35	39		57°00'	57°80'	57°19'	57°33'	58°86'	+1°53'	14°51'	14°75'	14°51'	14°59'	15°32'	-0°27'	21	Neptune not occulted. Windy.
29	10	37	6		351°52'	352°70'	351°62'	351°95'	353°30'	+1°35'	10°63'	10°65'	10°48'	10°59'	10°75'	+0°16'	30	
29	11	15	6		348°70'	349°25'	347°01'	348°32'	350°77'	+2°45'	10°80'	10°63'	10°86'	10°76'	10°75'	-0°01'	34	Neptune not occulted.
30	9	16	58		282°75'	282°39'	282°26'	282°47'	283°98'	+1°51'	15°11'	15°35'	15°27'	15°24'	15°18'	-0°06'	25	
31	8	8	53		244°58'	243°96'	244°83'	244°46'	244°48'	+0°02'	15°98'	16°25'	16°10'	16°11'	15°90'	-0°21'	25	
Feb. 10	8	55	20		336°17'	335°37'	337°38'	336°31'	336°90'	+0°59'	11°21'	10°86'	10°85'	10°97'	10°86'	-0°11'	6	
10	9	20	48		333°57'	332°97'	334°33'	333°62'	335°25'	+1°63'	10°79'	10°98'	11°08'	10°95'	10°91'	-0°04'	10	

Neptune not occulted. Windy.

Neptune not occulted.

Date, 1902.	d	h	m	s	Position-angle.					Distance.					Ex- posure.	Remarks.		
					D.	C.D.	P.M.	Mean.	Tab.	T-O.	D.	C.D.	P.M.	Mean.			Tab.	T-O.
Feb.	11	7	9	16	277°08	276°23	276°30	276°54	276°77	+0°23	15°86	15°89	15°87	15°87	15°83	-0°04	20 ^m	
	11	7	37	24	274°13	274°40	274°32	274°28	275°92	+1°64	15°67	15°83	15°95	15°82	15°91	+0°09	20	
	11	8	11	9	274°22	274°07	274°00	274°10	274°90	+0°80	16°10	15°99	15°84	15°98	16°01	+0°03	20½	
	11	8	39	21	273°75	273°85	273°72	273°77	274°08	+0°31	16°09	16°06	15°95	16°03	16°08	+0°05	20	
	12	7	51	5	233°48	233°12	232°25	232°95	233°50	+0°55	14°57	14°71	14°99	14°76	14°65	-0°11	20	
	13	8	13	25	151°67	151°43	152°95	152°02	153°93	+1°91	10°92	10°53	10°54	10°66	10°94	+0°28	30	Satellite badly defined.
	15	8	2	34	49°11	49°18	48°80	49°03	49°87	+0°84	14°18	13°89	13°88	13°98	14°22	+0°24	30	
	15	9	3	39	47°00	46°06	49°04	47°37	47°55	+0°18	13°73	13°56	13°92	13°74	13°95	+0°21	20	Satellite badly defined.
	16	7	5	31	330°15	329°62	329°92	329°90	332°68	+2°78	11°14	10°59	10°78	10°84	10°96	+0°12	20	Satellite badly defined.
	16	8	19	44	326°27	325°88	326°78	326°31	328°08	+1°77	11°16	11°25	10°91	11°11	11°14	+0°03	20½	
	28	7	59	1	309°30	309°10	308°96	309°12	309°68	+0°56	12°10	12°37	12°33	12°27	12°23	-0°04	21	
	28	8	48	39	308°08	307°13	308°56	307°92	307°25	-0°67	11°97	12°15	12°00	12°04	12°44	+0°40	20	
	28	9	26	28	305°73	304°88	305°43	305°35	305°45	+0°10	12°47	12°58	12°32	12°46	12°60	+0°14	20	
Mar.	1	8	27	0	258°13	257°30	257°88	257°77	259°57	+1°80	16°60	16°33	16°28	16°40	16°55	+0°15	21	
	3	7	19	54	125°72	126°46	126°45	126°21	127°27	+1°06	12°59	12°58	12°60	12°59	12°41	-0°18	20	
	3	8	5	20	124°65	124°08	124°75	124°49	125°12	+0°63	12°59	12°67	12°61	12°62	12°61	-0°01	15	
	3	8	29	1	122°57	123°22	123°03	122°94	124°02	+1°08	12°58	12°63	12°59	12°60	12°71	+0°11	20	
	3	9	6	0	121°20	121°29	121°56	121°35	122°33	+0°98	12°53	12°73	12°59	12°62	12°87	+0°25	20	
	3	9	34	45	121°12	121°04	120°74	120°97	121°05	+0°08	13°12	13°08	12°90	13°03	13°00	-0°03	20	

Date. 1902.	d	h	m	s	Position-angle.					Distance.					Ex- posure.	Remarks.		
					D.	O.D.	P.M.	Mean.	Tab.	T-O.	D.	O.D.	P.M.	Mean.			Tab.	T-O.
Mar. 17	17	9	49	44	357°08	356°23	355°62	356°31	358°54	+2°23	10°64	10°72	10°78	10°71	10°54	-0°17	20	Satellite in the glare of Nep- tune.
	19	7	59	16	245°35	245°10	245°33	245°26	245°48	+0°22	15°41	15°52	15°59	15°51	15°66	+0°15	10	
	19	8	24	43	244°17	244°42	244°32	244°30	244°72	+0°42	15°28	15°22	15°30	15°27	15°59	+0°32	10	
	19	8	52	16	242°92	243°37	243°15	243°15	243°89	+0°74	15°11	15°28	15°67	15°35	15°51	+0°16	10	
	21	8	6	21	102°73	102°70	103°68	103°04	104°17	+1°13	14°73	15°01	14°94	14°89	14°72	-0°17	12	
	21	8	35	26	102°80	103°17	103°26	103°08	103°20	+0°12	14°62	14°74	14°69	14°68	14°82	+0°14	12	
	21	9	16	6	100°07	100°67	100°51	100°42	101°87	+1°45	14°72	14°73	14°46	14°64	14°97	+0°33	12	
	22	9	25	4	59°37	59°65	59°61	59°54	60°13	+0°59	14°86	14°95	14°80	14°87	15°10	+0°23	12	
	25	6	57	55	239°65	239°69	239°31	239°55	241°99	+2°44	15°04	15°08	15°12	15°08	15°26	+0°18	20½	
	25	8	32	38	238°47	238°44	238°80	238°57	238°98	+0°41	14°75	14°85	14°87	14°82	14°95	+0°13	20	
	25	9	4	3	237°38	237°93	237°68	237°66	237°95	+0°29	14°97	14°92	15°06	14°98	14°84	-0°14	20	
	27	7	58	25	99°98	99°52	99°07	99°52	98°74	-0°78	14°77	15°10	15°05	14°97	15°25	+0°28	12	Satellite faint.
	27	8	19	55	96°18	96°28	95°23	95°90	98°07	+2°17	15°67	15°60	15°52	15°60	15°31	-0°29	12	Satellite faint.
	27	8	46	45	96°22	96°66	96°35	96°41	97°25	+0°84	15°54	15°53	15°77	15°61	15°40	-0°21	20	
	27	9	13	9	95°58	95°50	95°77	95°62	96°45	+0°83	15°66	15°55	15°22	15°48	15°47	-0°01	20	
Apr. 6	6	8	1	49	227°03	227°28	227°40	227°24	227°60	+0°36	13°47	13°31	13°22	13°33	13°57	+0°24	20	
10	10	8	11	37	319°50	319°25	318°75	319°17	319°76	+0°59	11°07	10°98	11°03	11°03	11°26	+0°23	15	
10	10	8	37	35	317°01	316°63	316°36	316°67	318°31	+1°64	11°20	11°21	11°10	11°17	11°35	+0°18	15	

Satellite
faint.

very

Satellite
faint.

very

*Observation of Saturn on 1902 July 17, made at Perth
Observatory, Western Australia.*

(Communicated by W. Ernest Cooke, M.A., Government Astronomer.)

As astronomers have been asked for observations of *Saturn* about July 17, I beg to report as follows :—

July 17 between 0^h and 1^h G.M.T. Definition remarkably good. Instrument, 10-inch guide telescope of astrograph. Power of eyepiece not measured but estimated about 600. The division could be distinctly traced across the planet, with no sign of a break.

This was the only chance we had, the weather on each side being cloudy or definition bad.

The north polar regions were very dark.

1902 July 21.

Observations of Comet Tempel 2, 1899 IV., at the Radcliffe Observatory, Oxford.

(Communicated by A. A. Rambaut, D.Sc., F.R.S., Radcliffe Observer.)

The following observations were made with the 10-inch Barclay Equatorial, using the Ring Micrometer with power 100.

Date.	G.M.T.			Local			Ob. server.	Comet minus Star. (Corrected for Refraction only).		No. of Compa.	Apparent R.A.		Parallax in R.A. P. _s	Log. (P × Δ).	Apparent N.P.D. of Comet.		Parallax in N.P.D. q.	Log. (q × Δ).	Ref.	
	h	m	s	h	m	s		R.A.	N.P.D.		h	m			s	°				'
1899.																				
June 12	12	42	32	18	1	57	R.	- 2 23'25	+ 1 47'9	3	19	50	24'22	- 0'31	94	46	(44'6)	13'5	0'8626	(a)
14	12	21	12	17	48	27	R.	- 4 40'81	- 0 12'4	5	19	53	13'34	- 0'36	95	3	31'6	13'8	0'8628	(b)
16	12	16	56	17	52	3	R.	+ 0 6'91	- 0 31'7	12	19	56	1'66	- 0'37	95	22	51'3	14'2	0'8641	(c)

Observer's Remarks.

- (a) Comet small and excessively faint. Observations on this night are only approximate; the resulting N.P.D. has, therefore, been bracketed.
 (b) The comet has a small nebulous head, with a stellar condensation of about magnitude 12. The comparison star is of the 10th magnitude.
 (c) The comet is small and faint, with a condensation of about the 12th magnitude. The magnitude of the comparison star is 11.

Adopted Places of the Comparison Stars.

Ref.	Mean R.A. 1899°			Reduction to Appar. R.A.			Mean N.P.D. 1899°			Reduction to Appar. N.P.D.			Authority.
	h	m	s	h	m	s	°	'	"	h	m	s	
(a)	19	52	43'88	+3'59	94	45	4	35	-7'65				Three observations Radcliffe Transit Circle, 1899.
(b)	19	57	50'54	+3'61	95	3	52	38	-8'40				Five observations R.A. and three observations N.P.D. Radcliffe Transit Circle, 1899.
(c)	19	55	51'07	+3'68	95	23	31	52	-8'61				Three observations Radcliffe Transit Circle, 1899.

In the computation of the parallaxes the adopted value of the Sun's mean horizontal parallax is 8''·85, and the geocentric distances, Δ, are taken from the *Astronomische Nachrichten*, No. 3554.

Observer: Mr. W. H. Robinson.

Old Cape Records of Comets. By R. T. A. Innes.

In arranging the old records of the Cape Observatory I came across a letter giving some records of comets seen from the Cape in the seventeenth century. With Sir David Gill's sanction I transmit a copy of it. The year of the letter is not given. It was probably written in 1858 to 1860, but the exact date is immaterial.

February 28.

My Dear Sir,—In my rapid progress through the old journals my eye has been caught by the notices of which I annex the translations. I may have passed over some others from the impossibility of attempting to do more than skim, but if there are any years in particular during which a more particular examination would [be] interesting to you, pray let me know the years, and I shall not fail to look more closely.—
I am, &c., (Signed) D. MOOLIN.

T. Maclear, Esq.

1664 December 15.—“About midnight, with a sky partially clouded, we all here saw a star with a darkish ray or tail, which it is said showed itself much more clearly and distinctly about 3 o'clock when it was near day; the star rose in the East and the tail pointed directly North.”

1686, Monday, August 12.—“This night appeared in the 5th house of the heavens, at one o'clock, in the horizon, a comet, corresponding in longitude (?) with *Saturn* and *Venus*, on the left shoulder of the *Hare*. S. Lat. $18^{\circ} 4'$, Long. $80^{\circ} 8'$. The tail extended right East and West to the length of 35 Celestial Degrees, in *Gemini*.”

1689 November 24.—“A star with a tail was seen in the [MS. defaced].”

1689 November 25.—“This morning about 4 o'clock the said tailed star was again seen, which soon after disappeared as the Sun rose.”

1689 December 9.—“This morning at 3 o'clock the tailed star showed itself very distinctly, the tail was more than 4 degrees long.”

1689 December 24.—“The tailed star no longer seen.”

On the Place of a Star near the Variable RU Herculis.
(Correction to former paper.) By F. A. Bellamy.

In a letter, Fr. Hagen has kindly drawn attention to a discrepancy between his observation and the position of star No. 19 as given in my paper (*Monthly Notices*, lxii. p. 75). Upon examination the cause was found to be in the transcription from the original measure sheets to the computation forms preliminary to conversion of measured coordinates to R.A. and Dec.: the line of figures opposite star No. 19 should read thus:—

19 11°0 8°33'63 5°6'320 6^m 16^s.76 23' 7''·4

The computations have been examined for the other stars but no further errors were found.

On Mr. Love's Formula for the Wave-Lengths of Nebular Lines.
By W. H. Wright.

(Communicated by the Secretaries.)

In the May number of the *Monthly Notices* of the Royal Astronomical Society, Mr. E. F. J. Love publishes a note on a relation which he considers to exist among the wave-lengths of some of the nebular lines. The supposed law, expressed in the general form adopted by Runge and others in their work on line series in the spectra of some of the elements, is as follows:

$$\lambda^{-1} = 25739 + 43108 n^{-2} - 1412208 n^{-4} \quad \dots \quad \dots \quad (1)$$

Such a law would be of the greatest interest and importance, not only by virtue of the fact that it would bring another spectrum into the line-series class, but also on account of the light it would shed on the composition of the nebulae by correlating a certain number of the "unknown" lines, and indicating their common origin. But, great as is the desideratum for such an expression of relation, the writer is inclined to doubt that any physical significance attaches to Mr. Love's formula. A number of reasons for this point of view will be given as briefly as possible.

In the following table the values of λ as determined from equation (1) are tabulated with n as argument:

TABLE I.

n				λ computed.	λ in nebulae.
3	...	...	...	7637.0	not observed.
4	...	...	...	4363.6	4363.3
5	...	...	...	3967.6	3967.6
6	...	...	...	3868.9	3868.9
7	...	...	...	41.6	not observed.
8	...	...	...	36.1	3836* (Campbell).
9	...	...	...	37.9	not observed.
10	...	...	...	41.9	3842 (Huggins).
11	...	...	...	46.3	not observed.
12	...	...	...	50.6	not observed.
13	...	...	...	54.4	3854 (Huggins).

By assuming $n = 11.5$ and 14.5 , additional approximate coincidences are secured with two of the lines observed by Huggins.

Let us examine somewhat critically the identities assumed by Mr. Love, as given in column three of the above table. As he points out, it is hardly probable that a line at $\lambda 7637$ would be observed in a nebular spectrum, supposing it were present. The agreement of the next three wave-lengths should follow as a matter of necessity, as they were used in computing the constants of the formula. Owing, however, to some slight numerical error, there is a discrepancy of 0.3 tenth-metre between the observed and computed values of the line $\lambda 4363$. Just what effect the correction of this error would have on the computed wave-lengths I have not determined. It is probable that the change would not amount in any case to more than one unit.

Passing for a moment the identification of the value $n = 8$, we come to the lines observed by Huggins. With regard to them it may be said that they are only a few of a group reported by that observer as existing in this region of the spectrum. The entire group is as follows: $\lambda\lambda$ 3896, 3887, 3878, 3870, 3859, 3854, 3848, 3842, 3832 and 3825. Under the circumstances some apparent coincidences are to be expected. Attention should moreover be called to the fact that there appears to be a systematic difference between Huggins's determinations and my own (from which the constants of Mr. Love's formula were computed) amounting to about +2.5 tenth-metres (W—H). This difference was determined from the three lines $\lambda\lambda$ 5007, 4959, and 3727, and is partly to be accounted for by the difference between the Angström and Rowland scales, amounting

* The wave-length published by Campbell is $\lambda 3835$. The wave-length given in the table is the one assumed by Mr. Love in his discussion.

in this region to about 0·8 tenth-metre. The reason for the choice of these particular lines is that they are the only lines measured by both Sir William Huggins and myself concerning which assumptions could not be made as to wave-length. The other lines measured by both observers were by each assumed to be due to hydrogen, and cannot therefore be used for the present purpose. Assuming that the difference +2·5 affects the group of lines under discussion, the coincidences in Table I. are destroyed. There is, however, a line in the group at λ 3848, and applying the correction we have a coincidence with the value 3850·6 corresponding to $n = 12$, a fact which indicates, perhaps, as much as anything else, the likelihood of occasional coincidences in a case of this sort. It should further be stated that the group of lines mentioned was observed only on the much discussed 1888 negative secured by Sir William and Lady Huggins. This photograph was taken fourteen years ago, and, although its indications were of remarkable interest, they have not since been confirmed, though attempts were made by several observers—notably Keeler, Campbell, and Huggins himself—to repeat the observations.

The only coincidence, then, to be taken seriously is that of λ 3836. This line has been identified by Campbell and others as $H\eta$ (λ 3835·6), and there is little reason to doubt that the identification is correct. It is one of a series of lines in the spectrum of the *Orion* nebula, the members of which decrease regularly in intensity towards the violet, and agree, within the limits of observational error, with the lines of the well-known hydrogen series. In Table II. are the wave-lengths as measured by Campbell in the nebular spectrum, and by Ames in the spectrum of hydrogen.

TABLE II.

Nebulæ.	Hydrogen tube.	Nebulæ.	Hydrogen tube.
4861	4861·5	3835	3835·6
4341	4340·6	3798	3798·0
4102	4101·9	3770	3770·7
3969	3970·2	3749	3750·2
3889	3889·2		

The wave-length λ 3969 in the nebular spectrum is of course that of the centre of gravity of the doublet $\lambda\lambda$ 3967·6 and 3970·2, which accounts for the apparent discrepancy shown by the table. λ 3749 is marked by Campbell as "very faint," and was therefore probably a difficult line to measure. In this case the residual is slightly over a tenth-metre, while in all the others the residuals are less than this amount. It is then difficult to interpret Mr. Love's statement, made in substantiation of his belief that "the hydrogen series beyond $H\epsilon$ has probably not yet been detected in nebular spectra," to the effect that he

finds it "much easier to believe some of Campbell's identifications wrong than to believe that his measurements are incorrect by three and four tenth-metres." Campbell's measurements seem to the writer to constitute a proof that the ultra-violet hydrogen series has been observed in the *Orion* nebula as far as $H\kappa$, and that the line $\lambda 3835$ is due to hydrogen. But, however that may be, evidence is not lacking that the line does not belong to a series including $\lambda\lambda 4363, 3968$, and 3869 . The line in question does not appear to vary in intensity in a regular manner with the latter lines, unless indeed the relation be an inverse one. The line $\lambda 3835$ and those in Table II. to the violet of it have been observed only in the *Orion* nebula, an object in which the hydrogen lines are unusually bright, and the three lines mentioned comparatively faint. It is in the planetary nebulae, in which the line $\lambda 3835$ is too faint for observation, that the three lines taken by Mr. Love as the basis of his series are bright.

In view of the above facts the writer considers that there is not a single coincidence between computed and observed wavelengths upon which the proposed formula can be considered to rest.

The writer considers it very doubtful whether $\lambda 4363$ is emitted under the same conditions as $\lambda\lambda 3968$ and 3869 . The latter lines are of about the same intensity in a number of different nebulae,* but the intensity of $\lambda 4363$ appears to vary relatively to them more than can be accounted for by instrumental considerations. So far as the three corresponding *Nova* bands being characterised by an identity of structure is concerned, the observations made at the Lick Observatory show the structure of all the brighter lines to be pretty much the same.

Lick Observatory: 1902 August.

Explanation of Use of Tables of $\frac{1}{2}(\theta + \cos \theta)$.

By W. Steadman Aldis, M.A.

The equations connecting the eccentric, true, and mean anomalies, and radius vector in an elliptic orbit are

$$(1) \quad m = u - e \sin u;$$

$$(2) \quad \tan \frac{v}{2} = \sqrt{\frac{1+e}{1-e}} \tan \frac{u}{2};$$

$$(3) \quad r = a(1 - e \cos u).$$

* Lick Observatory Bulletin, No. 19.

Putting $e = \sin \phi$, (1) becomes

$$\begin{aligned} m &= u - \sin \phi \sin u \\ &= \frac{1}{2} \{ \phi + u + \cos (\phi + u) \} - \frac{1}{2} \{ \phi - u + \cos (\phi - u) \} \\ &= C(\phi + u) - C(\phi - u) \end{aligned}$$

if $C(\theta)$ denote $\frac{1}{2}(\theta + \cos \theta)$.

The accompanying tables give the value of $C(\theta)$ in seconds for every minute of angle between -90° and $+90^\circ$.

For values beyond these limits it is easily shown that

$$\begin{aligned} C(180^\circ - \theta) &= N - C(\theta) \\ C(-180^\circ + \theta) &= -N - C(-\theta) \\ C(180^\circ + \theta) &= N - C(-\theta) \end{aligned}$$

where $N = 324000 =$ number of seconds in a right angle.

Examples of Use.

The Observatory, 1895 March, gave elements of Barnard's Comet.

Epoch 1895, Feb. 9^o, Berlin Mean Time.

$$M = 339^\circ 8', \phi = 35^\circ 43', \mu = 656'', \log a = 0.4886.$$

These give the values of the mean anomaly at midnight on the dates named according to the subjoined table :

Date.	Mean Anomaly.	Date.	Mean Anomaly.
May 26	-5584	May 31	-2304
27	-4928	June 1	-1648
28	-4272	2	-992
29	-3616	3	-336
30	-2960	4	+320

The negative sign merely indicates the anomaly as measured on the preceding side of the apse line.

To find the eccentric anomaly corresponding to mean anomaly $320''$ at June 4 midnight we have

$$320 = C(\phi + u) - C(\phi - u) \quad \dots \quad (a)$$

where ϕ

$$= 35^\circ 43'$$

The tables show that a change of $1'$ up or down in θ from $35^\circ 43'$ gives a change of about $12''.48$ in $C(\theta)$.

Hence the value of u to satisfy (a) will be about $\frac{320}{2 \times 12.48}$ minutes; that is to say, u lies between $12'$ and $13'$.

Take $u = 12'$; from the tables.

$$C(\phi + u) = C(35^\circ 55') = 148173'' \cdot 9463 \text{ diff. for } 1' \text{ in } u = 12'' \cdot 3982$$

$$C(\phi - u) = C(35^\circ 31') = 147874'' \cdot 2652 \left\{ \begin{array}{l} \text{" " in } u \\ \text{downwards} = 12'' \cdot 5754 \end{array} \right.$$

$$\text{difference} = \underline{299'' \cdot 6811}$$

This is too small by $20'' \cdot 3189$, and as an increase of $1'$ in u would increase this on the whole by $24 \cdot 9736$, the required increase must be $\frac{20 \cdot 3189}{24 \cdot 9736} \times 60'' = 48'' \cdot 8$.

Thus $u = 12' 48'' \cdot 8$.

Take midnight, May 26; neglecting the sign,

$$m = 5584'' = C(\phi + u) - C(\phi - u).$$

A first approximation, by difference opposite $35^\circ 43'$, gives

$$u = \frac{5584}{2 \times 12 \cdot 48} \text{ minutes} = 3^\circ 42' \text{ about.}$$

With this value

$$C(\phi + u) = C(39^\circ 25') = 150624'' \cdot 8251, \text{ diff. for } 60'' = 10'' \cdot 9480$$

$$C(\phi - u) = C(32^\circ 1') = 145075'' \cdot 3368 \left\{ \begin{array}{l} \text{" " " " } \\ \text{downwards} = 14'' \cdot 0987 \end{array} \right.$$

$$\text{difference} = \underline{5549'' \cdot 4883}$$

This is too small by $34'' \cdot 5117$, and u therefore must be increased by $\frac{34 \cdot 5117}{25 \cdot 0467} \times 60'' = 1' 22'' \cdot 7$.

Thus $u = 3^\circ 43' 22'' \cdot 7$.

When u is found (2) will give v . Equation (3) can be modified thus:

$$\begin{aligned} r &= a(1 - e \cos u) \\ \text{or } r &= a(1 - \sin \phi \cos u) \\ &= a \left\{ \frac{1 - \sin \phi + u}{2} + \frac{1 - \sin \phi - u}{2} \right\} \\ &= a \left\{ \left(\frac{dC}{d\theta} \right)_{\theta=\phi+u} + \left(\frac{dC}{d\theta} \right)_{\theta=\phi-u} \right\} \end{aligned}$$

Now the difference between two consecutive values of $C(\theta)$ in the tables, divided by 60, is clearly a very close approximation to the value of $\left(\frac{dC}{d\theta} \right)$ for a value of θ halfway between the two consecutive arguments.

In the last example

$$\phi = 35^\circ 43',$$

$$u = 3^\circ 43' 22'' \cdot 7$$

$$\phi + u = 39^\circ 26' 22'' \cdot 7, \quad \phi - u = 31^\circ 59' 37'' \cdot 3$$

$$\text{From the tables } \left(\frac{dC}{d\theta} \right)_{\theta=39^\circ 26' 30''} = \frac{10 \cdot 9412}{60} = 18235$$

while the value for $39^{\circ} 25' 30''$ is $\cdot 18247$. Thus the value of

$$\frac{dC}{d\theta} \text{ for } \theta = 39^{\circ} 26' 22''\cdot 7 \text{ is } \cdot 18236 \text{ very nearly.}$$

Similarly for

$$\theta = 31^{\circ} 59' 37''\cdot 3, \quad \frac{dC}{d\theta} = \cdot 23509$$

Thus

$$r = a \times \cdot 20878$$

which is accurate within the limits of the data.

Taking as an example an orbit of large eccentricity and also taking a large mean anomaly, that of Halley's Comet, Epoch 1910, (from *Encyclopædia Britannica*)

$$a = 17\cdot 9555, \text{ Period } 76\cdot 085 \text{ yrs., } e = \cdot 961733, \text{ T} = \text{May } 26\cdot 83.$$

Hence on May $26\cdot 83$, 1900, the mean anomaly of the comet was

$$\frac{10 \times 360 \times 60 \times 60}{76\cdot 085} \text{ seconds} = 170335''\cdot 8 \text{ nearly}$$

$$= 31^{\circ} 48' 55''\cdot 8 \text{ nearly}$$

$$\text{Since } m = u - e \sin u$$

$$u = m + e \sin m. \quad \text{1st approximation} \quad \dots \quad (A)$$

$$= m + (e + e^2 \cos m) \sin m$$

$$= m + e' \sin m. \quad \text{2nd approximation} \quad \dots \quad (B)$$

With the 1st approximation

$$u = C(m - \phi) - C(-m - \phi)$$

$$\text{But } m = \begin{matrix} 31^{\circ} & 48' & 55''\cdot 8 \\ \phi & 74 & 5 & 53\cdot 8 \end{matrix}$$

$$m - \phi = -42 \quad 16 \quad 58 = -42^{\circ} \quad 17' \text{ approximately}$$

$$m + \phi = 105 \quad 55 \quad \text{,,}$$

$$\text{Now } C(-105^{\circ} 55') = -N - C(-74^{\circ} 5').$$

Hence the first approximation to the value of u is given by

$$C(m - \phi) = 190^{\circ} 11' 194$$

$$N = 324000\cdot$$

$$324190\cdot 11' 194$$

$$C(-74^{\circ} 5') = -105067\cdot 0764$$

and

$$u = 219123\cdot 0430$$

$$= 60^{\circ} 52' 3'' \text{ nearly.}$$

Take as a trial value $u = 60^\circ 52'$

$$\phi = 74 \quad 6$$

$$C(\phi + u) = C(180^\circ - 45^\circ 2') = N - C(45^\circ 2')$$

$$C(\phi - u) = C(13^\circ 14')$$

$$C(45^\circ 2') = 153943''1829 \text{ diff. for } 60'' = 8''7713$$

$$C(13^\circ 14') = 124213.8138 \quad \text{,,} \quad \text{,,} \quad 23.1283$$

$$\text{sum} = 278156.9967$$

$$\underline{324000.}$$

$$m = 45843.0033$$

The deficiency in the value of m is $134492''.8$. The increase in the value of m for a change of $1'$ in u is at the present point about $8''.8 + 23''$, or roughly $32''$. If this continued uniform, an addition of $\frac{134492.8}{32}$ minutes would have to be made to u , or of $70^\circ 31'$.

This would make

$$u = 130^\circ 55', \quad \phi + u = 205^\circ 1' = 180^\circ + 25^\circ.1$$

$$\phi - u = -56^\circ 49'$$

and at this point a change of $1'$ in u would make a total change of $42''.7 + 55''.1$, or nearly $98''$, in m ; nearly three times the amount at starting. If we assume an average change of double the original value of the increment, the required change in u will be 35° . This gives $u = 95^\circ 52'$

$$\therefore (\phi + u) = 169^\circ 58' = 180^\circ - 10^\circ 2'$$

$$(\phi - u) = -21^\circ 46'.$$

$$\text{Hence } m = N - C(10^\circ 2') - C(-21^\circ 46').$$

Now

$$C(10^\circ 2') = 119615''1541, \text{ diff. for } 1' = 24''7691$$

$$C(-21^\circ 46') = 56599.2405 \quad \text{,,} \quad \text{,,} \quad 41.1289$$

$$\underline{176214.3946.}$$

$$\underline{324000.}$$

$$\text{Thus } m = 147785.6054$$

The deficiency is now $22550''$, and the change in m for an increase of $60''$ in u is about $66''$. This change increases as u increases, and if it be assumed on an average to be about $70''$, an increment to u of about 5° is needed.

Thus $u = 100^\circ 52'$
 and $m = N - C (5^\circ 2') - C (-26^\circ 46')$
 $C (5^\circ 2') = 111794''.7$, diff. for $1' = 27''.4$
 $C (-26^\circ 46') = 43901''.6$ „ „ $43'.5$
 155696.3
 324000
 $m = 168303.7$

deficiency now $= 2032''.1$, and as the change in m for a change of $60''$ in u is about $71''$, this requires an addition to u of about $\frac{2032.1}{71}$, or between $28'$ and $29'$.

Taking $28'$, $u = 101^\circ 20'$, and repeating the process, if it is desired to be very accurate, taking $\phi = 74^\circ 5' 53''.8$ instead of $74^\circ 6'$ it will turn out that the correct value is $101^\circ 20' 33''.2$, the error being less than a tenth of second.

The first guess can be often made more correct by taking (B) instead of (A), and finding an angle ϕ' such that

$$\sin \phi' = e + e^2 \cos m, \text{ whence (B) gives}$$

$$u = C (m - \phi') - C (-m - \phi')$$

as a first approximation. Or if $e + e^2 \cos m$ is greater than unity, writing 90° for ϕ'

$$u = C (m - 90^\circ) - C (-m - 90^\circ).$$

When u is known, r can be found from the column of differences, as in the former example.

Part 2.

A second use to which the tables can be applied is that of finding the elements of an elliptic orbit when two focal distances, the angle between them, and the time occupied in passing from one position to the other are known.

If (r, θ) , (r', θ') be the focal polar coordinates of the two positions, and t the time occupied in passing between them, it is known that the following equation holds:

$$\frac{kt}{a^{\frac{3}{2}}} = (\epsilon - \sin \epsilon) - (\delta - \sin \delta) \quad \dots \quad (1)$$

where $\cos \delta = 1 - \frac{r + r' - c}{2a} \quad \dots \quad (2)$

$$\cos \epsilon = 1 - \frac{r + r' + c}{2a} \quad \dots \quad (3)$$

c being the length of the chord joining the two points and k the measure of the attractive force at unit distance.

Equation (1) can be written

$$\frac{kt}{a^{\frac{1}{2}}} = \left\{ \frac{\pi}{2} - \delta + \cos \left(\frac{\pi}{2} - \delta \right) \right\} - \left\{ \frac{\pi}{2} - \varepsilon + \cos \left(\frac{\pi}{2} - \varepsilon \right) \right\}$$

$$\text{or } \frac{1}{2} \frac{kt}{a^{\frac{1}{2}}} = C(90 - \delta) - C(90 - \varepsilon) \quad \dots \quad \dots \quad \dots \quad (4)$$

if k be expressed in seconds and δ and ε in degrees and parts of a degree.

The angle δ lies between 0° and 180° , or between 180° and 360° , according as $\theta \sim \theta'$ is less or greater than 180° , while ε is only restricted to lie between 0° and 360° (Gauss, *Theoria Motus*, ed. 2, Gotha, 1877, p. 132).

The three equations (1), (2), (3) are sufficient to determine δ , ε , and a . The last two can be written

$$\sin^2 \frac{1}{2} \delta = \frac{r + r' - c}{4a} \quad \dots \quad \dots \quad \dots \quad (5)$$

$$\sin^2 \frac{1}{2} \varepsilon = \frac{r + r' + c}{4a} \quad \dots \quad \dots \quad \dots \quad (6)$$

$$\text{whence} \quad \sin \frac{1}{2} \delta = \sqrt{\frac{r + r' - c}{r + r' + c}} \cdot \sin \frac{1}{2} \varepsilon \quad \dots \quad \dots \quad (7)$$

The following process of successive approximation will give the value of a to as great a degree of accuracy as the data allow.

Assume any value for ε . From (7) the corresponding value of δ can be deduced, or, as is more useful in practice, a can be first derived from (6) and then δ from (5).

Placing the values of δ and ε in (4), by means of the tables of $C(\theta)$ another value of a is obtained. Let the values of a given by (6) and (4) be called x and y respectively.

Repeat this process with another assumed value of ε , and let x' and y' be the corresponding quantities on the second assumption. A comparison of $x' \sim y'$ with $x \sim y$ will indicate which of the two assumed values of ε is nearer the truth, and, with practice, will also give to a considerable degree of correctness the distance of the required value from the original assumption.

Taking an example worked out by Gauss (*Theoria Motus*, p. 103), we have

$$\log r = 0.3307640$$

$$\log r' = 0.3222239$$

$$\theta' - \theta = 7^\circ 34' 53''.73$$

$$t = 21.93391 \text{ days}$$

Also

$$\log k = 3.5500065746$$

$$\log t = 1.3411160571$$

whence

$$\log \left(\frac{1}{2} kt \right) = 4.5900926360$$

Ordinary trigonometrical processes give

$$c = 0.2835079$$

while

$$r + r' = 4.2417487$$

whence

$$r + r' + c = 4.5252566$$

$$r + r' - c = 3.9582408$$

And

$$\log \frac{r + r' + c}{4} = 0.0535832$$

$$\log \frac{r + r' - c}{4} = 9.9954422$$

For a first guess it is convenient to take $90^\circ - \epsilon = 0$.

Thus

$$L \sin \frac{1}{2} \epsilon = 9.8494850$$

$$\log \sin^2 \frac{1}{2} \epsilon = 9.6989700$$

$$\log \frac{r + r' + c}{4} = 0.0535832$$

Hence

$$\log x = 0.3546132$$

$$\log \frac{r + r' - c}{4} = 9.9954422$$

By (5)

$$\log \sin^2 \frac{1}{2} \delta = 9.6408290$$

$$L \sin \frac{1}{2} \delta = 9.8204145$$

Whence $\frac{1}{2} \delta = 41^\circ 24' 3''.4$ and $\delta = 82^\circ 48' 6''.8$

$$(90 - \delta) = 7^\circ 11' 53''.2$$

From the tables $C(7^\circ 11') = 115252''.9290$

$$\text{diff. for } 60'' = 26''.2443$$

Whence, neglecting second differences at this stage,

$$C(7^\circ 11' 53''.2) = 115276''.1989$$

Also

$$C(90 - \epsilon) = 103132''.4031$$

$$\text{difference} = 12143''.7958$$

The logarithm of this

$$= 4.0843545$$

$$\log \frac{1}{2} (kt) = 4.5900926$$

$$\log a^{\frac{2}{3}} = \text{the difference} = 0.5057381$$

$$\begin{array}{r} 3) 1.0114762 \\ \hline \end{array}$$

$$\log y = 0.3371587$$

The values of x and y are nearer than they usually come at the first guess. Experience, or the theory of the equations (6) and (4), shows that if ϵ be diminished both x and y increase, but y increases faster than x ; and if ϵ be increased x and y decrease,

the rate of change of y being the greater. As here y is less than x , it follows that in order to produce the required equality between them both must be increased, and ϵ and δ consequently diminished.

As a second guess take $\epsilon = 80^\circ$. By the same process as above $\delta = 73^\circ 54' 26'' \cdot 73$.

$$\log x = 0.4374482$$

$$\log y = 0.4407142$$

Thus y is now greater than x , and the second value of ϵ is too small.

Roughly, the values of x and y for $\epsilon = 90^\circ$ and $\epsilon = 80^\circ$ are $x_1 = 2.2626$, $y_1 = 2.1735$, $x_2 = 2.7381$, $y_2 = 2.7588$. Thus

$$x_1 - y_1 = .0891, y_2 - x_2 = .0207$$

and, assuming that $x \sim y$ changes uniformly with ϵ , this would give as the correct value of ϵ about $81^\circ 53' 7''$.

In the later stages of approximation it is generally best to take two trial values of ϵ between which the real value lies, the simultaneous working of which is not much more labour than that of one separately, as far as reference to tables is concerned. A little practice will show what can easily be proved, that the rate of change of $y \sim x$ increases as δ decreases, and *vice versa*. Hence the real value of ϵ in this case is less than $81^\circ 53' 7''$. Taking as two trial values for ϵ , $81^\circ 54'$ and $81^\circ 30'$, the corresponding values of δ are $75^\circ 36' 30'' \cdot 6$ and $75^\circ 15' 2'' \cdot 74$, while the values of $\log x$ and $\log y$ are given by

$$\left. \begin{array}{l} \log x_1 = 0.4205700 \\ \log y_1 = 0.4201511 \end{array} \right\} \text{ and } \left. \begin{array}{l} \log x_2 = 0.4240764 \\ \log y_2 = 0.4244420 \end{array} \right\}$$

The required value of ϵ must evidently therefore lie between $81^\circ 30'$ and $81^\circ 54'$, and not very far from halfway between them. As another pair of trial values taking $\epsilon = 81^\circ 40'$ and $\epsilon = 81^\circ 42'$, by the same process it will be found that

$$\left. \begin{array}{l} \log x_1 = 0.4226124 \\ \log y_1 = 0.4226428 \end{array} \right\} \quad \left. \begin{array}{l} \log x_2 = 0.4223202 \\ \log y_2 = 0.4222933 \end{array} \right\}$$

The real value of ϵ is thus intermediate between these two.

The value of a must therefore lie between x_1 and x_2 : that is, between 2.6461 and 2.6443 . In many cases this will be near enough, but if greater accuracy is required a pair of closer values may be tried, from which it will be found that for $\epsilon = 81^\circ 41' 11'' \cdot 5$, the values of $\log x$ and $\log y$ coincide for seven figures, each of them being 0.4224385 . The value given by Gauss is 0.4224389 , the discrepancy being within the limits of error accumulating in the use of seven-figure logarithms.

The discovery of the value of a , by means of the equations

(4), (6), and (7), may be considered as the discovery of the point of intersection of two curves whose equations are of the forms

$$y = \frac{\lambda}{\sin^2 \frac{1}{2}x} \quad \dots \quad \dots \quad \dots \quad (1)$$

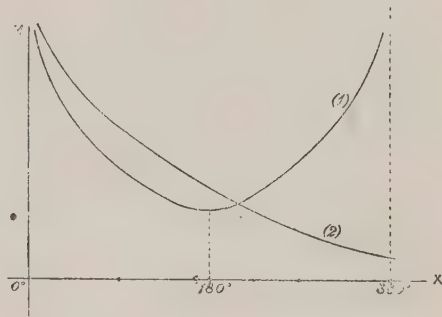
$$\frac{\mu}{y^{\frac{1}{2}}} = (x' - \sin x') - (x - \sin x) \quad \dots \quad \dots \quad (2)$$

where x' is a function of x given by an equation of the form

$$\sin \frac{1}{2}x' = \nu \sin \frac{1}{2}x,$$

λ , μ , ν being given constants.

The ordinate of the point of intersection is the required value of a .



The general form of these curves is as represented in the diagram. The axis of y is asymptotic to both, but, while the ordinate of (1) decreases until $x = 180^\circ$, and then increases till it becomes infinite again when $x = 360^\circ$, the ordinate of (2) continually decreases as x passes from 0° to 360° . It is not difficult to prove that in all cases of elliptic orbits the ordinate of (2) is greater than that of (1) for very small values of x . Obviously the two curves will cut each other in one point, and one point only, between the permissible limits of the value of x .

If then the values of the ordinate for each of the curves be calculated for two assumed values of x , as in the example worked out, and the points be marked down on a piece of scale paper, curves of the required general shape can be roughly drawn through the pairs of points thus found, and the point of their intersection will give an approximate starting point for the closer calculation of the correct value.

When in any example the value of a has been thus obtained, the values of the eccentricity and semilatus rectum can be found.

The formulæ for this purpose are easily shown to be

$$p = \frac{2rr' \sin^2 \Delta}{c} \tan \frac{1}{2} \psi \text{ or } \frac{2rr' \sin^2 \Delta}{c} \cot \frac{1}{2} \psi$$

where p is the semilatus rectum, 2Δ the angle between the given radii vectores, and ψ an acute angle determined by the equation

$$\left(r + r' - \frac{rr' \cos^2 \Delta}{a}\right) \sin \psi = c.$$

In the formula for p the value $\tan \frac{1}{2} \psi$ or $\cot \frac{1}{2} \psi$ has to be taken according as 2Δ , or $\theta' - \theta$ is greater or less than 180° . When p is known and a , the value of c can be obtained from the

formula $p = a(1 - e^2)$, or if $e = \sin \phi$, $\cos \phi = \sqrt{\frac{p}{a}}$.

In using this method for finding a it is better to make an assumption for the value of ϵ than for that of δ although the range of possible values for the former is double that for the latter, for two reasons. First, for any assumed value of ϵ , equation (7) only gives one value of δ , while for an assumed value of δ it would give two possible ones for ϵ ; secondly, any assumed value for ϵ will give a real value for δ , while this would not always be the case if the opposite method were adopted.

In the tables negative values of $C(\theta)$ are denoted by a black line at the right of the column.

In cases where there was a little doubt as to whether the figure after the fourth decimal ought to be $5+$ or $5-$, so that there was uncertainty as to the exact value of the last figure retained, that value has been chosen which made the sequence of the second differences most regular.

A dot placed after a decimal whose last significant figure is 5, thus $\cdot 6345\cdot$ or $\cdot 6350\cdot$ denotes that the real value is slightly less. This enables the last digit or two digits to be cut off with accuracy in all cases.

The writer desires to acknowledge his obligation to Professor G. H. Darwin for valuable hints as to the construction and the method of application of the Tables.

Δ^2 .	Diff.	0° .	,	-0° .	Diff.	Δ^2 .	Δ^2 .	Diff.	1° .
86	"	103132"	0	103132"	"	86	87	"	104916"
88	29'9957	162'3988	1	102'3988	30'0043	88	88	29'4721	104916'6956
87	'9869	192'3857	2	072'3857	'0131	88	88	'4633	946'1677
88	'9782	222'3639	3	042'3639	'0218	87	87	'4546	104975'6310
87	'9694	252'3333	4	103012'3333	'0306	88	87	'4459	105005'0856
87	'9607	282'2940	5	102982'2940	'0393	87	88	'4371	034'5315
87	'9520	312'2460	6	952'2460	'0480	87	86	'4285	063'9686
87	'9433	342'1893	7	922'1893	'0567	87	88	'4197	093'3977
88	'9346	372'1239	8	892'1239	'0654	87	87	'4110	122'8168
87	'9258	402'0497	9	862'0497	'0742	88	88	'4022	152'2278
87	'9171				'0829	87	86	'3936	181'6300
87	'9084	431'9668	10	831'9668	'0916	87	88	'3848	211'0236
88	'8996	461'8752	1	801'8752	'1004	88	87	'3761	240'4084
87	'8909	491'7748	2	771'7748	'1091	87	88	'3673	269'7845
87	'8822	521'6657	3	741'6657	'1178	87	86	'3587	299'1518
87	'8735	551'5479	4	711'5479	'1265	87	88	'3499	328'5105
88	'8647	581'4214	15	681'4214	'1353	88	87	'3412	357'8604
87	'8560	611'2861	6	651'2861	'1440	87	88	'3324	387'2016
87	'8473	641'1421	7	621'1421	'1527	87	86	'3238	416'5340
87	'8386	670'9894	8	590'9894	'1614	87	88	'3150	445'8578
88	'8298	700'8280	9	560'8280	'1702	88	87	'3063	475'1728
87	'8211	730'6578	20	530'6578	'1789	87	87	'2976	504'4791
87	'8124	760'4789	1	500'4789	'1876	87	88	'2888	533'7767
87	'8037	790'2913	2	470'2913	'1963	87	87	'2801	563'0655
88	'7949	820'0950	3	440'0950	'2051	88	87	'2714	592'3456
87	'7862	849'8899	4	409'8899	'2138	87	87	'2627	621'6170
88	'7775	879'6761	25	379'6761	'2225	88	87	'2540	650'8797
88	'7687	909'4536	6	349'4536	'2313	88	88	'2452	680'1337
87	'7600	939'2223	7	319'2223	'2400	87	87	'2365	709'3789
87	'7513	968'9823	8	288'9823	'2487	87	88	'2277	738'6154
87	'7426	103998'7336	9	258'7336	'2574	87	86	'2191	767'8431
88	'7338	104028'4762	30	228'4762	'2662	88	88	'2103	797'0622
87	'7251	058'2100	1	198'2100	'2749	87	87	'2016	826'2725
87	'7164	087'9351	2	167'9351	'2836	87	87	'1929	855'4741
88	'7076	117'6515	3	137'6515	'2924	88	87	'1842	884'6670
86	'6990	147'3591	4	107'3591	'3010	86	88	'1754	913'8512
88	'6902	177'0581	35	077'0581	'3098	88	87	'1667	943'0266
87	'6815	206'7483	6	046'7483	'3185	87	87	'1580	105972'1933
87	'6728	236'4298	7	102016'4298	'3272	87	88	'1493	106001'3513
88	'6640	266'1026	8	101986'1026	'3360	88	87	'1405	030'5006
87	'6553	295'7666	9	955'7666	'3447	87	86	'1319	059'6411
87	'6466	325'4219	40	925'4219	'3534	87	88	'1231	088'7730
88	'6378	355'0685	1	895'0685	'3622	88	88	'1143	117'8961
87	'6291	384'7063	2	864'7063	'3709	87	86	'1057	147'0104
87	'6204	414'3354	3	834'3354	'3796	87	88	'0969	176'1161
87	'6117	443'9558	4	803'9558	'3883	87	87	'0882	205'2130
88	'6030	473'5675	45	773'5675	'3970	87	87	'0795	234'3012
88	'5942	503'1705	6	743'1705	'4058	88	87	'0708	263'3807
87	'5855	532'7647	7	712'7647	'4145	87	88	'0620	292'4515
87	'5768	562'3502	8	682'3502	'4232	87	87	'0533	321'5135
88	'5680	591'9270	9	651'9270	'4320	88	87	'0446	350'5668
87	'5593	621'4950	50	621'4950	'4407	87	87	'0359	379'6114
87	'5506	651'0543	1	591'0543	'4494	87	88	'0271	408'6473
88	'5419	680'6049	2	560'6049	'4581	87	87	'0184	437'6744
87	'5331	710'1468	3	530'1468	'4669	88	87	'0097	466'6928
87	'5244	739'6799	4	499'6799	'4756	87	87	'0010	495'7025
87	'5157	769'2043	55	469'2043	'4843	87	87	28'9923	524'7035
88	'5070	798'7200	6	438'7200	'4930	87	88	'9836	553'6958
88	'4982	828'2270	7	408'2270	'5018	88	88	'9748	582'6792
86	'4896	857'7252	8	377'7252	'5104	86	87	'9661	611'6542
88	29'4808	887'2148	9	347'2148	'5192	88	88	28'9573	640'6202
		104916'6956	60	101316'6956					106669'5776

	-1° .	Diff.	Δ° .	Δ° .	Diff.	2° .		-2° .	Diff.	Δ° .
0	101316.6956	"	87	86	"	106669.5776	0	99469.5776	"	86
1	286.1677	30.5279	88	88	28.9487	698.5263	1	438.5263	31.0513	88
2	255.6310	.5367	87	87	.9399	727.4662	2	407.4662	.0601	87
3	225.0856	.5454	87	87	.9312	756.3974	3	376.3974	.0688	87
4	194.5315.	.5541	88	87	.9225	785.3199	4	345.3199	.0775	87
5	163.9686	.5629	86	88	.9138	814.2337	5	314.2337	.0862	88
6	133.3971	.5715	88	86	.9050	843.1387	6	283.1387	.0950	86
7	102.8168	.5803	87	88	.8964	872.0351	7	252.0351	.1036	88
8	072.2278	.5890	88	87	.8876	900.9227	8	220.9227	.1124	87
9	041.6300	.5978	86	88	.8789	929.8016	9	189.8016	.1211	88
		.6064			.8701				.1299	
10	101011.0236	.6152	88	86	.8615	958.6717	10	158.6717	.1385	86
1	100980.1084	.6239	87	88	.8527	106987.5332	1	127.5332	.1473	88
2	949.7845.	.6327	88	87	.8440	107016.3859	2	096.3859	.1560	87
3	919.1518	.6413	86	87	.8353	045.2299	3	065.2299	.1647	87
4	888.5105.	.6501	88	87	.8266	074.0652	4	034.0652	.1734	87
15	857.8604	.6588	87	88	.8178	102.8918	15	99002.8918	.1822	88
6	827.2016	.6676	88	87	.8091	131.7096	6	98971.7096	.1909	87
7	796.5340	.6762	86	87	.8004	160.5187	7	940.5187	.1996	87
8	765.8578	.6850	88	87	.7917	189.3191	8	909.3191	.2083	87
9	735.1728	.6937	87	87	.7830	218.1108	9	878.1108	.2170	87
20	704.4791	.7024	87	88	.7742	246.8938	20	846.8938	.2258	88
1	673.7767	.7112	88	86	.7656	275.6680	1	815.6680	.2344	86
2	643.0655	.7199	87	88	.7568	304.4336	2	784.4336	.2432	88
3	612.3456	.7286	87	87	.7481	333.1904	3	753.1904	.2519	87
4	581.6170	.7373	87	88	.7393	361.9385.	4	721.9385.	.2607	88
25	550.8797	.7460	88	86	.7307	390.6778	25	690.6778	.2693	86
6	520.1337	.7548	88	87	.7219	419.4085.	6	659.4085.	.2781	87
7	489.3789	.7635	87	87	.7132	448.1304	7	628.1304	.2868	87
8	458.6154	.7723	88	87	.7045	476.8436	8	596.8436	.2955	87
9	427.8431	.7809	86	87	.6958	505.5481	9	565.5481	.3042	87
30	397.0622	.7897	88	87	.6871	534.2439	30	534.2439	.3129	87
1	366.2725	.7984	87	88	.6783	562.9310	1	502.9310	.3217	88
2	335.4741	.8071	87	87	.6696	591.6093	2	471.6093	.3304	87
3	304.6670	.8158	88	87	.6609	620.2789	3	440.2789	.3391	87
4	273.8512	.8246	87	87	.6522	648.9398	4	408.9398	.3478	87
35	243.0266	.8333	87	87	.6435	677.5920	35	377.5920	.3565	87
6	212.1933	.8420	87	88	.6348	706.2355.	6	346.2355.	.3652	88
7	181.3513	.8507	87	88	.6260	734.8703	7	314.8703	.3740	88
8	150.5006	.8595	88	87	.6173	763.4963	8	283.4963	.3827	87
9	119.6411	.8681	86	87	.6086	792.1136	9	252.1136	.3914	87
40	088.7730	.8769	88	87	.5999	820.7222	40	220.7222	.4001	87
1	057.8961	.8857	88	87	.5912	849.3221	1	189.3221	.4088	87
2	100027.0104	.8943	86	88	.5824	877.9133	2	157.9133	.4176	88
3	99996.1161	.9031	87	87	.5737	906.4957	3	126.4957	.4263	87
4	965.2130	.9118	87	87	.5650	935.0694	4	095.0694	.4350	87
45	934.3012	.9205	87	87	.5563	963.6344	45	063.6344	.4437	87
6	903.3807	.9292	88	87	.5476	107992.1907	6	032.1907	.4524	87
7	872.4515.	.9380	88	87	.5389	108020.7383	7	98000.7383	.4611	87
8	841.5135.	.9467	87	88	.5301	049.2772	8	97969.2772	.4699	88
9	810.5668	.9554	87	87	.5214	077.8073	9	937.8073	.4786	87
50	779.6114	.9641	88	86	.5128	106.3287	50	906.3287	.4872	86
1	748.6473	.9729	87	88	.5040	134.8415.	1	874.8415.	.4960	88
2	717.6744	.9816	87	87	.4953	163.3455	2	843.3455	.5047	87
3	686.6928	.9903	87	88	.4865	191.8408	3	811.8408	.5135	88
4	655.7025	30.9990	87	86	.4779	220.3273	4	780.3273	.5221	86
55	624.7035	31.0077	87	88	.4691	248.8052	55	748.8052	.5309	88
6	593.6958	.0164	88	87	.4604	277.2743	6	717.2743	.5396	87
7	562.6794	.0252	88	87	.4517	305.7347	7	685.7347	.5483	87
8	531.6542	.0339	87	86	.4431	334.1864	8	654.1864	.5569	86
9	500.6203	.0427	88	88	.4343	362.6295.	9	622.6295.	.5657	88
60	99469.5776	31.0427		28.4343	108391.0638	60	97591.0638	31.5657		

Δ°.	Diff.	3°.	'	-3°.	Diff.	Δ°.	Δ°.	Diff.	4°.
88	"	108391'0638	0	97591'0638	"	88	86	110081'1777	
87	28'4255	419'4893	1	559'4893	31'5745	87	87	27'0030	109'0807
86	'4168	447'9061	2	527'9001	'5832	86	88	'8943	136'9750.
88	'4082	476'3143	3	496'3143	'5918	88	87	'8855	164'8605
87	'3994	504'7137	4	464'7137	'6006	87	86	'8768	192'7373
87	'3907	533'1044	5	433'1044	'6093	87	88	'8682	220'6055.
87	'3820	561'4864	6	401'4864	'6180	87	86	'8594	248'4644
88	'3733	589'8597	7	369'8597	'6267	88	88	'8508	276'3155
86	'3645	618'2242	8	338'2242	'6355	86	87	'8420	304'1577
88	'3559	646'5801	9	306'5801	'6441	88	87	'8333	331'9910
	'3471				'6529			'8246	
86		674'9272	10	274'9272		86	87	'8159	359'8156
88	'3385	703'2657	1	243'2657	'6615	88	87	'8072	387'6315.
87	'3297	731'5954	2	211'5954	'6703	87	87	'7985	415'4387
88	'3210	759'9164	3	179'9164	'6790	88	87	'7898	443'2372
86	'3122	788'2286	4	148'2286	'6878	86	87	'7811	471'0270
87	'3036	816'5322	15	116'5322	'6964	87	87	'7724	498'8081
88	'2949	844'8271	6	084'8271	'7051	88	87	'7637	526'5805
86	'2861	873'1132	7	053'1132	'7139	86	87	'7550	554'3442
88	'2775	901'3907	8	97021'3907	'7225	88	88	'7462	582'0992
87	'2687	929'6594	9	96989'6594	'7313	87	86	'7376	609'8454
	'2600				'7400				
87	'2513	957'9194	20	957'9194	'7487	87	87	'7289	637'5830
87	'2426	108986'1707	1	926'1707	'7574	87	87	'7202	665'3119
88	'2339	109014'4133	2	894'4133	'7661	88	88	'7115	693'0321
86	'2251	042'6472	3	862'6472	'7749	86	88	'7027	720'7436
88	'2165	070'8723	4	830'8723	'7835	88	86	'6941	748'4463
86	'2077	099'0888	25	799'0888	'7923	86	87	'6854	776'1404
87	'1991	127'2965	6	767'2965	'8009	87	87	'6767	803'8258
88	'1903	155'4956	7	735'4956	'8097	88	87	'6680	831'5025
87	'1816	183'8659	8	703'8659	'8184	87	87	'6593	859'1705.
87	'1729	211'8675.	9	671'8675.	'8271	87	87	'6506	886'8298
87	'1642	240'0404	30	640'0404	'8358	87	88	'6418	914'4804
87	'1555	268'2046	1	608'2046	'8445	87	86	'6332	942'1222
88	'1467	296'3601	2	576'3601	'8533	88	87	'6245	969'7554
86	'1381	324'5068	3	544'5068	'8619	86	88	'6157	110997'3799
88	'1293	352'6449	4	512'6449	'8707	88	86	'6071	111024'9956
87	'1206	380'7742	35	480'7742	'8794	87	87	'5984	052'6027
86	'1120	408'8948	6	448'8948	'8880	86	87	'5897	080'2011
88	'1032	437'0068	7	417'0068	'8968	88	87	'5810	107'7908
87	'0945	465'1100	8	385'1100	'9055	87	88	'5722	135'3718
86	'0859	493'2045	9	353'2045	'9141	86	86	'5636	162'9440
88	'0771	521'2904	40	321'2904	'9229	88	87	'5549	190'5076
88	'0683	549'3675.	1	289'3675.	'9317	88	87	'5462	218'0625
87	'0596	577'4358	2	257'4358	'9404	87	87	'5375	245'6087
86	'0510	605'4954	3	225'4954	'9490	86	87	'5288	273'1462
87	'0423	633'5464	4	193'5464	'9577	87	87	'5201	300'6750
88	'0335	661'5887	45	161'5887	'9665	88	87	'5114	328'1951
86	'0249	689'6222	6	129'6222	'9751	86	87	'5027	355'7065.
87	'0162	717'6471	7	097'6471	'9838	87	86	'4941	383'2092
88	28'0074	745'6633	8	065'6633	31'9926	88	88	'4853	410'7033
87	27'9987	773'6707	9	033'6707	32'0013	87	87	'4766	438'1886
87	'9900	801'6694	50	96001'6694	'0100	87	87	'4679	465'6652
87	'9813	829'6594	1	95969'6594	'0187	87	87	'4592	493'1331
87	'9726	857'6407	2	937'6407	'0274	87	86	'4506	520'5923
87	'9639	885'6133	3	905'6133	'0361	87	88	'4418	548'0429
87	'9552	913'5772	4	873'5772	'0448	87	86	'4332	575'4847
87	'9465	941'5324	55	841'5324	'0535	87	88	'4244	602'9179
87	'9378	969'4789	6	809'4789	'0622	87	86	'4158	630'3423
88	'9290	109997'4167	7	777'4167	'0710	88	88	'4070	657'7581
86	'9204	110025'3457	8	745'3457	'0796	86	86	'3984	685'1651
88	27'9116	053'2661	9	713'2661	32'0884	88	87	'3897	712'5635
		110081'1777	60	95681'1777					111739'9532

	-4°.	Diff.	Δ°.	Δ°.	Diff.	5°.		-5°.	Diff.	Δ°.
0	95681.1777	"	86	88	"	111739.9532	0	93739.9532	"	88
1	649.0807	32.0970	87	86	27.3809	767.3341	1	707.3341	32.6191	86
2	616.9750.	.1057	88	86	.3723	794.7064	2	674.7064	.6277	86
3	584.8605	.1145	87	88	.3637	822.0701	3	642.0701	.6363	88
4	552.7373	.1232	86	87	.3549	849.4250.	4	609.4250.	.6451	87
5	520.6055.	.1318	88	87	.3462	876.7712	5	576.7712	.6538	87
6	488.4649	.1406	86	87	.3375	904.1087	6	544.1087	.6625	87
7	456.3157	.1492	88	87	.3288	931.4375	7	511.4375	.6712	87
8	424.1577	.1580	87	86	.3201	958.7576	8	478.7576	.6799	87
9	391.9910	.1667	87	88	.3115	111986.0691	9	446.0691	.6885	88
		.1754			.3027				.6973	
10	359.8156	.1841	87	86	.2941	112013.3718	10	413.3718	.7059	86
1	327.6315.	.1928	87	88	.2854	040.6659	1	380.6659	.7146	87
2	295.4387	.2015	87	86	.2766	067.9513	2	347.9513	.7234	88
3	263.2372	.2102	87	86	.2680	095.2279	3	315.2279	.7320	86
4	231.0270	.2189	87	87	.2593	122.4959	4	282.4959	.7407	87
15	198.8081	.2276	87	87	.2506	149.7552	15	249.7552	.7494	87
6	166.5805	.2363	87	87	.2419	177.0058	6	217.0058	.7581	87
7	134.3442	.2450	87	86	.2333	204.2477	7	184.2477	.7667	86
8	102.0992	.2538	88	88	.2245	231.4810	8	151.4810	.7755	88
9	069.8454	.2624	86	86	.2159	258.7055	9	118.7055	.7841	86
20	037.5830	.2711	87	88	.2071	285.9214	20	085.9214	.7929	88
1	95005.3119	.2798	87	86	.1985	313.1285.	1	053.1285.	.8015	86
2	94973.0321	.2885	87	87	.1898	340.3270	2	93020.3270	.8102	87
3	940.7436	.2973	88	87	.1811	367.5168	3	92987.5168	.8189	87
4	908.4463	.3059	86	87	.1724	394.6979	4	954.6979	.8276	87
25	876.1404	.3146	87	87	.1637	421.8703	25	921.8703	.8363	87
6	843.8258	.3233	87	86	.1550	449.0340	6	889.0340	.8450	87
7	811.5025	.3320	87	86	.1464	476.1890	7	856.1890	.8536	86
8	779.1705.	.3407	87	88	.1376	503.3354	8	823.3354	.8624	88
9	746.8298	.3494	87	86	.1290	530.4730	9	790.4730	.8710	86
30	714.4804	.3582	88	87	.1203	557.6020	30	757.6020	.8797	87
1	682.1222	.3668	86	87	.1116	584.7223	1	724.7223	.8884	87
2	649.7554	.3755	87	87	.1029	611.8339	2	691.8339	.8971	87
3	617.3799	.3843	88	87	.0942	638.9368	3	658.9368	.9058	87
4	584.9956	.3929	86	87	.0855	666.0310	4	626.0310	.9145	87
35	552.6027	.4016	87	86	.0769	693.1165	35	593.1165	.9231	86
6	520.2011	.4103	87	87	.0682	720.1934	6	560.1934	.9318	87
7	487.7908	.4190	87	87	.0595	747.2616	7	527.2616	.9405	87
8	455.3718	.4278	88	87	.0508	774.3211	8	494.3211	.9492	87
9	422.9440	.4364	86	87	.0421	801.3719	9	461.3719	.9579	87
40	390.5076	.4451	87	87	.0334	828.4140	40	428.4140	.9666	87
1	358.0625	.4538	87	86	.0248	855.4474.	1	395.4474.	.9752	86
2	325.6087	.4625	87	88	.0160	882.4722	2	362.4722	.9840	86
3	293.1462	.4712	87	86	.0074	909.4882	3	329.4882	.9926	86
4	260.6750	.4799	87	87	.26.9987	936.4956	4	296.4956	.32.9926	87
45	228.1951	.4886	87	87	.9900	963.4943	45	263.4943	.33.0013	87
6	195.7065.	.4973	87	86	.9814	112990.4843	6	230.4843	.0100	86
7	163.2092	.5059	86	88	.9726	113017.4657	7	197.4657	.0186	88
8	130.7033	.5147	88	86	.9640	044.4383	8	164.4383	.0274	86
9	098.1886	.5234	87	87	.9553	071.4023	9	131.4023	.0360	87
									.0447	
50	065.6652	.5321	87	87	.9466	098.3576	50	098.3576	.0534	87
1	033.1331	.5408	87	87	.9379	125.3042	1	065.3042	.0621	87
2	94000.5923	.5494	86	86	.9293	152.2421	2	92032.2421	.0707	86
3	93968.0429	.5582	88	88	.9205	179.1714	3	91999.1714	.0795	88
4	935.4847	.5668	86	86	.9119	206.0919	4	966.0919	.0881	86
55	902.9179	.5756	88	87	.9032	233.0038	55	933.0038	.0968	87
6	870.3423	.5842	86	87	.8945	259.9070	6	899.9070	.1055	87
7	837.7581	.5930	88	86	.8859	286.8015	7	866.8015	.1141	86
8	805.1651	.6016	86	88	.8771	313.6874	8	833.6874	.1229	88
9	772.5635	.6103	87	86	.8685	340.5645	9	800.5645	.1315	86
60	93739.9532	.6190				113367.4330	60	91767.4330		

Δ^a .	Diff.	6°	'	-6° .	Diff.	Δ^a .	Δ^a .	Diff.	7° .
87	"	113367	"	91767	"	87	86	"	114963
86	26'8598	394'2928	1	734'2928	33'1402	86	86	26'3396	114990
88	'8512	421'1440	2	701'1440	'1488	88	88	'3310	115016
86	'8424	447'9864	3	667'9864	'1576	86	86	'3222	042'6626
87	'8338	474'8202	4	634'8202	'1662	87	87	'3136	068'9762
87	'8251	501'6453	5	601'6453	'1749	87	86	'3049	095'2811
87	'8164	528'4617	6	568'4617	'1836	87	86	'2963	121'5774
86	'8077	555'2694	7	535'2694	'1923	86	88	'2877	147'8651
87	'7991	582'0685	8	502'0685	'2009	87	86	'2789	174'1440
87	'7904	608'8589	9	468'8589	'2096	87	86	'2703	200'4143
87	'7817				'2183	87	86	'2617	
87		635'6406	10	435'6406	'2270	87	87	'2530	226'6760
86	'7730	662'4136	1	402'4136	'2356	86	87	'2443	252'9290
87	'7644	689'1780	2	369'1780	'2443	87	86	'2357	279'1733
87	'7557	715'9337	3	335'9337	'2530	87	87	'2270	305'4090
87	'7470	742'6807	4	302'6807	'2617	87	87	'2183	331'6360
86	'7383	769'4190	15	269'4190	'2703	86	86	'2097	357'8543
88	'7297	796'1487	6	236'1487	'2791	88	86	'2011	384'0640
86	'7209	822'8696	7	202'8696	'2877	86	87	'1924	410'2651
86	'7123	849'5819	8	169'5819	'2963	86	87	'1837	436'4575
87	'7037	876'2856	9	136'2856	'3051	88	86	'1751	462'6412
88	'6949								
86	'6863	902'9805	20	102'9805	'3137	86	87	'1664	488'8163
87	'6776	929'6668	1	069'6668	'3224	87	86	'1578	514'9827
86	'6690	956'3444	2	036'3444	'3310	86	87	'1491	541'1405
87	'6603	113983'0134	3	91003'0134	'3397	87	86	'1405	567'2896
87	'6516	114009'6737	4	90969'6737	'3484	87	87	'1318	593'4301
87	'6429	036'3253	25	936'3253	'3571	87	87	'1231	619'5619
87	'6342	069'9682	6	902'9682	'3658	87	86	'1145	645'6850
86	'6256	089'6024	7	869'6024	'3744	86	86	'1059	671'7995
87	'6169	116'2280	8	836'2280	'3831	87	87	'0972	697'9054
87	'6082	142'8449	9	802'8449	'3918	87	87	'0885	724'0026
86		169'4531	30	769'4531	'4004	86	86	'0799	750'0911
87	'5996	196'0527	1	736'0527	'4091	87	87	'0712	776'1710
87	'5909	222'6436	2	702'6436	'4178	87	86	'0626	802'2422
86	'5822	249'2258	3	669'2258	'4264	86	86	'0540	828'3048
87	'5736	275'7994	4	635'7994	'4351	87	87	'0453	854'3588
87	'5649	302'3643	35	602'3643	'4438	87	87	'0366	880'4041
87	'5562	328'9205	6	568'9205	'4525	87	86	'0280	906'4407
86	'5475	355'4680	7	535'4680	'4611	86	87	'0193	932'4687
87	'5389	382'0069	8	502'0069	'4698	87	86	'0107	958'4880
87	'5302	408'5371	9	468'5371	'4784	86	87	26'0020	115984'4987
86	'5216								
87		435'9587	40	435'9587	'4871	87	86		116010'5007
87	'5042	461'5716	1	401'5716	'4958	87	87	25'9934	036'4941
87	'4955	488'0758	2	368'0758	'5045	87	86	'9847	062'4781
86	'4869	514'5713	3	334'5713	'5131	86	86	'9761	088'4544
87	'4782	541'0582	4	301'0582	'5218	87	87	'9675	114'4222
86	'4696	567'5364	45	267'5364	'5304	86	87	'9588	140'3811
87	'4609	594'0060	6	234'0060	'5391	87	86	'9501	166'3311
87	'4522	620'4669	7	200'4669	'5478	87	86	'9415	192'2721
87	'4435	646'9191	8	166'9191	'5565	87	87	'9329	218'2055
86	'4349	673'3626	9	133'3626	'5651	86	87	'9242	244'1299
87		699'7975	50	099'7975	'5738	87	85		270'0455
86	'4262	726'2237	1	066'2237	'5824	86	88	'9070	295'9521
87	'4176	752'6413	2	90032'6413	'5911	87	86	'8982	321'8501
87	'4089	779'0502	3	89999'0502	'5998	87	86	'8896	347'7401
86	'4002	805'4504	4	965'4504	'6084	86	86	'8810	373'6211
87	'3916	831'8420	55	931'8420	'6171	87	87	'8724	399'4931
87	'3829	858'2249	6	898'2249	'6258	87	87	'8637	425'3571
86	'3742	884'5991	7	864'5991	'6344	86	86	'8550	451'2121
87	'3656	910'9647	8	830'9647	'6431	87	86	'8464	477'0581
87	'3569	937'3216	9	797'3216	'6518	87	86	'8378	502'8961
87	26'3482	114963'6698	60	89763'6698			25'8292		116528'7251

	-7° .	Diff.	Δ^2 .	Δ^2 .	Diff.	8° .		-8° .	Diff.	Δ^2 .
0	89763''6698	"	86	87	"	116528''7257	0	87728''7257	"	87
1	730''0094	33'6604	86	87	25'8205	554'5462	1	694'5462	34'1795	87
2	696'3404	'6690	88	86	'8118	580'3580	2	660'3580	'1882	86
3	662'6626	'6778	88	86	'8032	606'1612	3	626'1612	'1968	87
4	628'9762	'6864	87	85	'7945	631'9557	4	591'9557	'2055	85
5	595'2811	'6951	86	87	'7860	657'7417	5	557'7417	'2140	87
6	561'5774	'7037	86	87	'7773	683'5190	6	523'5190	'2227	87
7	527'8651	'7123	88	86	'7686	709'2876	7	489'2876	'2314	86
8	494'1440	'7211	86	86	'7600	735'0476	8	455'0476	'2400	86
9	460'4143	'7297	86	87	'7514	760'7990	9	420'7990	'2486	87
		'7383			'7427				'2573	
10	426'6760	'7470	87	86	'7341	786'5417	10	386'5417	'2659	86
1	392'9290	'7557	87	86	'7255	812'2758	1	352'2758	'2745	86
2	359'1733	'7643	86	88	'7167	838'0013	2	318'0013	'2833	88
3	325'4090	'7730	87	85	'7082	863'7180	3	283'7180	'2918	85
4	291'6360	'7817	87	86	'6996	889'4262	4	249'4262	'3004	86
15	257'8543	'7903	86	87	'6909	915'1258	15	215'1258	'3091	87
6	224'0640	'7989	86	87	'6822	940'8167	6	180'8167	'3178	87
7	190'2651	'8076	87	85	'6737	966'4989	7	146'4989	'3263	85
8	156'4575	'8163	87	87	'6650	116992'1726	8	112'1726	'3350	87
9	122'6412	'8249	86	86	'6564	117017'8376	9	077'8376	'3436	86
20	088'8163	'8336	87	87	'6477	043'4940	20	043'4940	'3523	87
1	054'9827	'8422	86	87	'6390	069'1417	1	87009'1417	'3610	87
2	89021'1405	'8509	87	85	'6305	094'7807	2	86974'7807	'3695	85
3	88987'2896	'8595	86	87	'6218	120'4112	3	940'4112	'3782	87
4	953'4301	'8682	87	86	'6132	146'0330	4	906'0330	'3868	86
25	919'5619	'8769	87	86	'6046	171'6462	25	871'6462	'3954	86
6	885'6850	'8855	86	87	'5959	197'2508	6	837'2508	'4041	87
7	851'7995	'8941	86	86	'5873	222'8467	7	802'8467	'4127	86
8	817'9054	'9028	87	86	'5787	248'4340	8	768'4340	'4213	86
9	784'0026	'9115	87	87	'5700	274'0127	9	734'0127	'4300	87
30	750'0911	'9201	86	86	'5614	299'5827	30	699'5827	'4386	86
1	716'1710	'9288	87	86	'5528	325'1441	1	665'1441	'4472	86
2	682'2422	'9374	86	87	'5441	350'6969	2	630'6969	'4559	87
3	648'3048	'9460	86	86	'5355	376'2410	3	596'2410	'4645	86
4	614'3588	'9547	87	86	'5269	401'7765	4	561'7765	'4731	86
35	580'4041	'9634	87	86	'5183	427'3034	35	527'3034	'4817	86
6	546'4407	'9720	86	87	'5096	452'8217	6	492'8217	'4904	87
7	512'4687	'9807	87	86	'5010	478'3313	7	458'3313	'4990	86
8	478'4880	'9893	86	86	'4924	503'8323	8	423'8323	'5076	86
9	444'4987	'9980	87	87	'4837	529'3247	9	389'3247	'5163	87
40	410'5007	'0066	86	86	'4751	554'8084	40	854'8084	'5249	86
1	376'4941	'0153	87	86	'4665	580'2835	1	320'2835	'5335	86
2	342'4788	'0239	86	86	'4579	605'7500	2	285'7500	'5421	86
3	308'4549	'0325	87	87	'4492	631'2079	3	251'2079	'5508	87
4	274'4224	'0412	87	86	'4406	656'6571	4	216'6571	'5594	86
45	240'3812	'0499	86	86	'4320	682'0977	45	182'0977	'5680	86
6	206'3313	'0585	86	86	'4234	707'5297	6	147'5297	'5766	86
7	172'2728	'0671	86	87	'4147	732'9531	7	112'9531	'5853	87
8	138'2057	'0758	87	86	'4061	758'3678	8	078'3678	'5939	86
9	104'1299	'0845	87	86	'3975	783'7739	9	043'7739	'6025	86
50	070'0454	'0930	85	86	'3889	809'1714	50	86009'1714	'6111	86
1	035'9524	'1018	88	87	'3802	834'5603	1	85974'5603	'6198	87
2	88001'8506	'1104	86	86	'3716	859'9405	2	939'9405	'6284	86
3	87967'7402	'1190	86	86	'3630	885'3121	3	905'3121	'6370	86
4	933'6212	'1276	87	86	'3544	910'6751	4	870'6751	'6456	86
55	899'4936	'1363	87	86	'3458	936'0295	55	836'0295	'6542	86
6	865'3573	'1450	87	87	'3371	961'3753	6	801'3753	'6629	87
7	831'2123	'1536	86	86	'3285	117986'7124	7	766'7124	'6715	86
8	797'0587	'1622	86	86	'3199	118012'0409	8	732'0409	'6801	86
9	762'8965	'1708	86	86	'3113	037'3608	9	697'3608	'6887	86
60	87728'7257					118062'6721	60	85662'6721		

Δ^2 .	Diff.	9° .	'	-9° .	Diff.	Δ^2 .	Δ^2 .	Diff.	10° .			
86	"	118062	6721	0	85662	6721	86	85	119565	5901		
87	25'3027	087	9748	1	627	9748	34	6973	87	86	590	376
86	2940	113	2688	2	593	2688	7060	86	86	7777	615	154
86	2854	138	5542	3	558	5542	7146	86	86	7691	639	923
86	2768	163	8310	4	523	8310	7232	86	85	7604	664	683
86	2682	189	0992	5	489	0992	7318	86	86	7519	689	435
87	2596	214	3588	6	454	3588	7404	87	86	7433	714	178
86	2509	239	6097	7	419	6097	7491	86	86	7347	738	913
85	2423	264	8520	8	384	8520	7577	85	85	7261	763	639
87	2338	290	0858	9	350	0858	7662	87	87	7176	788	357
	2251						7749			7089		
87	2164	315	3109	10	315	3109	7836	87	86	7003	813	066
85	2079	340	5273	1	280	5273	7921	85	85	6918	837	766
86	1993	365	7352	2	245	7352	8007	86	86	6832	862	458
87	1906	390	9345	3	210	9345	8094	87	87	6745	887	141
86	1820	416	1251	4	176	1251	8180	86	85	6660	911	815
86	1734	441	3071	15	141	3071	8266	86	86	6574	936	481
85	1649	466	4805	6	106	4805	8351	85	86	6488	961	139
87	1562	491	6454	7	071	6454	8438	87	86	6402	119985	788
87	1475	516	8016	8	036	8016	8525	87	85	6317	120010	428
85	1390	541	9491	9	85001	9491	8610	85	87	6230	035	060
86	1304	567	0881	20	84967	0881	8696	86	85	6145	059	683
87	1217	592	2185	1	932	2185	8783	87	86	6059	084	297
85	1132	617	3402	2	897	3402	8868	85	86	5973	108	903
87	1045	642	4534	3	862	4534	8955	87	86	5887	133	500
86	0959	667	5579	4	827	5579	9041	86	86	5801	158	086
86	0873	692	6538	25	792	6538	9127	86	85	5716	182	666
86	0787	717	7411	6	757	7411	9213	86	86	5630	207	241
86	0701	742	8198	7	722	8198	9299	86	86	5544	231	804
86	0615	767	8899	8	687	8899	9385	86	86	5458	256	358
87	0528	792	9514	9	652	9514	9472	87	86	5372	280	904
85	0443	818	0042	30	618	0042	9557	85	86	5286	305	441
86	0357	843	0485	1	583	0485	9643	86	85	5201	329	976
87	0270	868	0842	2	548	0842	9730	87	86	5115	354	496
85	0185	893	1112	3	513	1112	9815	85	86	5029	379	003
87	0098	918	1297	4	478	1297	9902	87	86	4943	403	504
85	25'0013	943	1395	35	443	1395	9987	85	85	4858	427	991
86	24'9926	968	1408	6	408	1408	0074	86	87	4771	452	481
86	9840	118993	1334	7	373	1334	0160	86	85	4686	476	961
86	9754	119018	1174	8	338	1174	0246	86	86	4600	501	434
85	9669	043	0928	9	303	0928	0331	85	85	4515	525	894
87	9582	068	0597	40	268	0597	0418	87	86	4429	550	34
86	9496	093	0179	1	233	0179	0504	86	87	4342	574	78
86	9410	117	9675	2	197	9675	0590	86	85	4257	599	211
85	9325	142	9085	3	162	9085	0675	85	85	4172	623	61
87	9238	167	8410	4	127	8410	0762	87	86	4086	648	06
86	9152	192	7648	45	092	7648	0848	86	86	4000	672	471
86	9066	217	6800	6	057	6800	0934	86	86	3914	696	87
86	8980	242	5866	7	84022	5866	1020	86	86	3828	721	26
86	8894	267	4846	8	83987	4846	1106	86	85	3743	745	64
86	8808	292	3740	9	952	3740	1192	86	86	3657	770	01
85	8723	317	2548	50	917	2548	1277	85	86	3571	794	38
87	8636	342	1271	1	882	1271	1364	87	85	3486	818	74
86	8550	366	9907	2	846	9907	1450	86	86	3400	843	09
86	8464	391	8457	3	811	8457	1536	86	86	3314	867	43
85	8379	416	6921	4	776	6921	1621	85	85	3229	891	76
87	8292	441	5300	55	741	5300	1708	87	87	3142	916	08
86	8206	466	3592	6	706	3592	1794	86	85	3057	940	39
85	8121	491	1798	7	671	1798	1879	85	85	2972	964	70
87	8034	515	9919	8	635	9919	1966	87	86	2886	120989	00
86	7948	540	7953	9	600	7953	2052	86	86	2800	121013	29
		119565	5901	60	83565	5901	35	2052			121037	57

-10° .	Diff.	Δ°	Δ°	Diff.	11°	11°	-11° .	Diff.	Δ°
83565.5901	"	85	85	"	121037.5704	0	81437.5704	"	85
530.3764	35.2137	86	87	24.2715	061.8419	1	401.8419	35.7285	87
495.1541	2223	86	85	2628	086.1047	2	366.1047	7372	85
459.9232	2309	87	85	2543	110.3590	3	330.3590	7457	85
424.6836	2396	85	86	2458	134.6048	4	294.6048	7542	86
389.4355	2481	86	86	2372	158.8420	5	258.8420	7628	86
354.1788	2567	86	86	2286	183.0706	6	223.0706	7714	86
318.9135	2653	86	85	2200	207.2906	7	187.2906	7800	85
283.6396	2739	85	85	2115	231.5021	8	151.5021	7885	85
248.3572	2824	87	86	2030	255.7051	9	115.7051	7970	86
	2911			1944				8056	
213.0661	2997	86	86	1858	279.8995	10	079.8995	8142	86
177.7664	3082	85	86	1772	304.0853	1	044.0853	8228	86
142.4582	3168	86	85	1687	328.2625	2	81008.2625	8313	85
107.1414	3255	87	86	1601	352.4312	3	80972.4312	8399	86
071.8159	3340	85	85	1516	376.5913	4	936.5913	8484	85
036.4819	3426	86	86	1430	400.7429	15	900.7429	8570	86
83001.1393	3512	86	85	1345	424.8859	6	864.8859	8655	85
82965.7881	3598	86	86	1259	449.0204	7	829.0204	8741	86
930.4283	3683	85	85	1174	473.1463	8	793.1463	8826	85
895.0600	3770	87	87	1087	497.2637	9	757.2637	8913	87
859.6830	3855	85	85	1002	521.3724	20	721.3724	8998	85
824.2975	3941	86	85	0917	545.4726	1	685.4726	9083	86
788.9034	4027	86	86	0831	569.5643	2	649.5643	9169	86
753.5007	4113	86	86	0745	593.6474	3	613.6474	9255	86
718.0894	4199	85	84	0661	617.7219	4	577.7219	9339	84
682.6695	4284	85	87	0574	641.7880	25	541.7880	9426	87
647.2111	4370	86	85	0489	665.8454	6	505.8454	9511	85
611.8041	4456	86	85	0404	689.8943	7	469.8943	9596	86
576.3585	4542	86	86	0318	713.9347	8	433.9347	9682	86
540.9043	4628	86	86	0232	737.9665	9	397.9665	9768	86
505.4415	4714	86	85	0147	761.9897	30	361.9897	9853	85
469.9701	4799	86	86	0061	786.0044	1	326.0044	9939	86
434.4902	4885	86	85	24.9976	810.0105	2	290.0105	36.0024	85
399.0017	4971	86	86	9890	834.0081	3	254.0081	0110	86
363.5046	5057	85	85	9791	857.9971	4	217.9971	0195	85
327.9989	5142	85	86	9805	881.9776	35	181.9776	0281	86
292.4847	5229	87	85	9719	905.9495	6	145.9495	0366	85
256.9618	5314	86	86	9634	929.9129	7	109.9129	0452	86
221.4304	5399	86	85	9548	953.8677	8	073.8677	0537	85
185.8904	5485	85	85	9463	121977.8140	9	037.8140	0622	85
				9378					
150.3419	5571	86	86	9292	122001.7518	40	80001.7518	0708	86
114.7848	5658	87	86	9206	025.6810	1	79965.6810	0794	86
079.2190	5743	85	85	9121	049.6016	2	929.6016	0879	85
043.6447	5828	85	85	9036	073.5137	3	893.5137	0964	85
82008.0619	5914	86	86	8950	097.4173	4	857.4173	1050	86
81972.4705	6000	86	85	8865	121.3123	45	821.3123	1135	85
936.8705	6086	86	85	8780	145.1988	6	785.1988	1220	86
901.2619	6172	86	86	8694	169.0768	7	749.0768	1306	86
865.6447	6257	85	86	8608	192.9462	8	712.9462	1392	86
830.0190	6343	86	85	8523	216.8070	9	676.8070	1477	85
794.3847	6429	86	86	8437	240.6593	50	640.6593	1563	86
758.7418	6514	85	84	8353	264.5030	1	604.5030	1647	84
723.0904	6600	86	86	8267	288.3383	2	568.3383	1733	86
687.4304	6686	86	86	8181	312.1650	3	532.1650	1819	86
651.7618	6771	85	85	8096	335.9831	4	495.9831	1904	85
616.0847	6858	87	85	8011	359.7927	55	459.7927	1989	85
580.3989	6943	85	86	7925	383.5938	6	423.5938	2075	86
544.7046	7028	85	85	7840	407.3863	7	387.3863	2160	85
509.0018	7114	86	85	7755	431.1703	8	351.1703	2245	86
473.2004	7200	86	86	7669	454.9458	9	314.9458	2331	86
81437.5704	35.7200			23.7669	122478.7127	60	79278.7127		

Δ^2	Diff.	12°		-12°	Diff.	Δ^2	Δ^2	Diff.	13°							
86	"	122478	"	7127	0	79278	"	7127	86	85	23	2472	123889	"	120	
84	23	7583			1	242	4710			36	2417					84
86		7499		502	4710	1	242	4710			2501					84
86		7413		526	2209	2	206	2209			2587					86
85		7328		549	9622	3	169	9622			2672					85
86		7242		573	6950	4	133	6950			2758					86
85		7157		597	4192	5	097	4192			2843					85
85		7072		621	1349	6	061	1349			2928					85
86		6987		644	8421	7	79024	8421			3013					85
86		6901		668	5408	8	78988	5408			3099					86
86		6815		692	2309	9	952	2309			3185					86
84		6731		715	9124	10	915	9124			3269					84
86		6645		739	5855	1	879	5855			3355					86
85		6560		763	2500	2	843	2500			3440					85
86		6475		786	9060	3	806	9060			3525					86
85		6389		810	5535	4	770	5535			3611					85
86		6304		834	1924	15	734	1924			3696					86
85		6219		857	8228	6	697	8228			3781					85
86		6133		881	4447	7	661	4447			3867					86
84		6049		905	0580	8	625	0580			3951					84
86		5963		928	6629	9	588	6629			4037					86
86		5877		952	2592	20	552	2592			4123					86
84		5793		975	8469	1	515	8469			4207					84
86		5707		122999	4262	2	479	4262			4293					86
85		5622		123022	9969	3	442	9969			4378					85
86		5537		046	5591	4	406	5591			4463					86
84		5451		070	1128	25	370	1128			4549					84
86		5367		093	6579	6	333	6579			4633					86
85		5281		117	1946	7	297	1946			4719					85
86		5196		140	7227	8	260	7227			4804					86
85		5111		164	2423	9	224	2423			4889					85
86		5025		187	7534	30	187	7534			4975					86
84		4940		151	2559	1	151	2559			5060					84
86		4856		234	7499	2	114	7499			5144					86
85		4770		258	2355	3	078	2355			5230					85
86		4685		281	7125	4	041	7125			5315					86
85		4599		305	1810	35	78005	1810			5401					85
86		4514		328	6409	6	77968	6409			5486					86
84		4430		352	0923	7	932	0923			5570					84
86		4344		375	5353	8	895	5353			5656					86
85		4259		398	9697	9	858	9697			5741					85
86		4174		422	3956	40	822	3956			5826					86
84		4088		445	8130	1	785	8130			5912					84
85		4004		469	2218	2	749	2218			5996					85
86		3919		492	6222	3	712	6222			6081					86
85		3833		516	0141	4	676	0141			6167					85
86		3748		539	3974	45	639	3974			6252					86
85		3663		562	7722	6	602	7722			6337					85
86		3578		586	1385	7	566	1385			6422					86
85		3493		609	4963	8	529	4963			6507					85
86		3408		632	8456	9	492	8456			6592					86
85		3323		656	1864	50	456	1864			6677					85
86		3237		679	5187	1	419	5187			6763					86
84		3153		702	8424	2	382	8424			6847					84
86		3067		726	1577	3	346	1577			6933					86
84		2983		749	4644	4	309	4644			7017					84
86		2897		772	7627	55	272	7627			7103					86
85		2812		796	0524	6	236	0524			7188					85
86		2728		819	3336	7	199	3336			7272					86
85		2642		842	6064	8	162	6064			7358					85
86		2557		865	8706	9	125	8706			7443					86
85	23	2557		123889	1263	60	77089	1263			36	7443				85
86		2472		123889	1263	60	77089	1263			36	7443				86
85		2387		123889	1263	60	77089	1263			36	7443				85
86		2303		123889	1263	60	77089	1263			36	7443				86
85		2217		123889	1263	60	77089	1263			36	7443				85
86		2132		123889	1263	60	77089	1263			36	7443				86
85		2047		123889	1263	60	77089	1263			36	7443				85
86		1962		123889	1263	60	77089	1263			36	7443				86
85		1877		123889	1263	60	77089	1263			36	7443				85
86		1792		123889	1263	60	77089	1263			36	7443				86
85		1707		123889	1263	60	77089	1263			36	7443				85
86		1622		123889	1263	60	77089	1263			36	7443				86
85		1538		123889	1263	60	77089	1263			36	7443				85
86		1452		123889	1263	60	77089	1263			36	7443				86
85		1367		123889	1263	60	77089	1263			36	7443				85
86		1283		123889	1263	60	77089	1263			36	7443				86
85		1197		123889	1263	60	77089	1263			36	7443				85
86		1113		123889	1263	60	77089	1263			36	7443				86
85		1027		123889	1263	60	77089	1263			36	7443				85
86		0943		123889	1263	60	77089	1263			36	7443				86
85		0858		123889	1263	60	77089	1263			36	7443				85
86		0772		123889	1263	60	77089	1263			36	7443				86
85		0688		123889	1263	60	77089	1263			36	7443				85
86		0603		123889	1263	60	77089	1263			36	7443				86
85		0518		123889	1263	60	77089	1263			36	7443				85
86		0433		123889	1263	60	77089	1263			36	7443				86
85		0349		123889	1263	60	77089	1263			36	7443				85
86		0263		123889	1263	60	77089	1263			36	7443				86
85		0179		123889	1263	60	77089	1263			36	7443				85
86		0093		123889	1263	60	77089	1263			36	7443				86
85		0009		123889	1263	60	77089	1263			36	7443				85
86		582		123889	1263	60	77089	1263			36	7443				86
85		605		123889	1263	60	77089	1263			36	7443				85
86		628		123889	1263	60	77089	1263			36	7443				86
85		651		123889	1263	60	77089	1263			36	7443				85
86		674		123889	1263	60	77089	1263			36	7443				86
85		697		123889	1263	60	77089	1263			36	7443				85
86		720		123889	1263	60	77089	1263			36	7443				86
85		743		123889	1263	60	77089	1263			36	7443				85
86		766		123889	1263	60	77089	1263			36	7443				86
85		789		123889	1263	60	77089	1263			36	7443				85
86		812		123889	1263	60	77089	1263			36	7443				86
85		835		123889	1263	60	77089	1263			36	7443				85
86		858		123889	1263	60	77089	1263			36	7443				86
85		881		123889	1263	60	77089	1263			36	7443				85
86		903		123889	1263	60	77									

-13° .	Diff.	Δ° .	Δ° .	Diff.	14° .		-14° .	Diff.	Δ° .
77089''1263	"	85	85	"	125268''9300	0	74868''9300	"	85
052'3735	36'7528	85	85	22'7381	291'6681	1	831'6681	37'2619	85
77015'6122	'7613	84	84	'7296	314'3977	2	794'3977	'2704	84
76978'8425	'7697	86	85	'7212	337'1189	3	757'1189	'2788	85
942'0642	'7783	85	84	'7127	359'8316	4	719'8316	'2873	84
905'2774	'7868	85	85	'7043	382'5359	5	682'5359	'2957	85
868'4821	'7953	85	85	'6958	405'2317	6	645'2317	'3042	85
831'6783	'8038	85	85	'6873	427'9190	7	607'9190	'3127	85
794'8660	'8123	85	84	'6788	450'5978	8	570'5978	'3212	84
758'0452	'8208	85	85	'6704	473'2682	9	533'2682	'3296	85
	'8293			'6619				'3381	
721'2159	'8378	85	84	'6535	495'9301	10	495'9301	'3465	84
684'3781	'8462	84	85	'6450	518'5836	1	458'5836	'3550	85
647'5319	'8548	86	84	'6366	541'2286	2	421'2286	'3634	84
610'6771	'8633	85	85	'6281	563'8652	3	383'8652	'3719	85
573'8138	'8717	84	85	'6196	586'4933	4	346'4933	'3804	85
536'9421	'8803	86	84	'6112	609'1129	15	309'1129	'3888	84
500'0618	'8887	84	85	'6027	631'7241	6	271'7241	'3973	85
463'1731	'8973	86	85	'5942	654'3268	7	234'3268	'4058	85
426'2758	'9057	84	84	'5858	676'9210	8	196'9210	'4142	84
389'3701	'9142	85	84	'5774	699'5068	9	159'5068	'4226	84
352'4559	'9228	86	85	'5689	722'0842	20	122'0842	'4311	85
315'5331	'9312	84	85	'5604	744'6531	1	084'6531	'4396	85
278'6019	'9357	85	84	'5520	767'2135	2	047'2135	'4480	84
241'6622	'9482	85	84	'5435	789'7655	3	74009'7655	'4565	85
204'7140	'9567	84	85	'5351	812'3090	4	73972'3090	'4649	84
167'7573	'9651	86	84	'5266	834'8441	25	934'8441	'4734	85
130'7922	'9737	84	85	'5182	857'3707	6	897'3707	'4818	84
93'8185	'9821	86	84	'5097	879'8889	7	859'8889	'4903	85
056'8364	'9907	84	85	'5013	902'3986	8	822'3986	'4987	84
76019'8457	36'9991			'4928	924'8999	9	784'8999	'5072	85
75982'8466	37'0076	85	84	'4844	947'3927	30	747'3927	'5156	84
945'8390	'0161	85	85	'4759	969'8771	1	709'8771	'5241	85
908'8229	'0245	84	84	'4675	125992'3530	2	672'3530	'5325	84
871'7984	'0331	86	85	'4590	126014'8205	3	634'8205	'5410	85
834'7653	'0416	85	84	'4506	037'2795	4	597'2795	'5494	84
797'7237	'0500	84	84	'4422	059'7301	35	559'7301	'5578	84
760'6737	'0585	85	85	'4337	082'1723	6	522'1723	'5663	85
723'6152	'0670	85	85	'4252	104'6060	7	484'6060	'5748	85
686'5482	'0754	84	84	'4168	127'0312	8	447'0312	'5832	84
649'4728	'0840	86	84	'4084	149'4480	9	409'4480	'5916	84
612'3888	'0924	84	85	'3999	171'8564	40	371'8564	'6001	85
575'2964	'1009	85	84	'3915	194'2563	1	334'2563	'6085	84
538'1955	'1094	85	85	'3830	216'6478	2	296'6478	'6170	85
501'0861	'1179	84	84	'3746	239'0308	3	259'0308	'6254	84
463'9682	'1263	85	84	'3662	261'4054	4	221'4054	'6338	84
426'8419	'1348	85	85	'3577	283'7716	45	183'7716	'6423	85
389'7071	'1433	85	84	'3493	306'1293	6	146'1293	'6507	84
352'5638	'1518	85	85	'3408	328'4786	7	108'4786	'6592	85
315'4120	'1602	84	84	'3324	350'8194	8	070'8194	'6676	84
278'2518	'1687	85	84	'3240	373'1518	9	73033'1518	'6760	84
241'0831	'1772	85	84	'3156	395'4758	50	72995'4758	'6844	85
203'9059	'1857	85	85	'3071	417'7914	1	957'7914	'6929	84
166'7202	'1941	84	85	'2986	440'0985	2	920'0985	'7014	85
129'5261	'2026	85	83	'2903	462'3971	3	882'3971	'7097	85
92'3235	'2111	85	85	'2818	484'6874	4	844'6874	'7182	83
055'1124	'2196	84	84	'2734	506'9692	55	806'9692	'7266	81
75017'8928	'2280	84	85	'2649	529'2426	6	769'2426	'7351	85
74980'6648	'2364	84	84	'2565	551'5075	7	731'5075	'7435	84
943'4284	'2450	86	85	'2480	573'7640	8	693'7640	'7520	85
906'1834	37'2534	84	83	22'2397	596'0120	9	656'0120	'7603	83
74868'9300					126618'2517	60	72618'2517		

Δ°	Diff.	15°		-15°	Diff.	Δ°	Δ°	Diff.	16°
85	"	126618'2517	0	72618'2517	"	85	83	"	127937'22
84	22'2312	640'4829	1	580'4829	37'7688	84	84	21'7267	958'95
84	'2228	662'7057	2	542'7057	'7772	84	84	'7183	127980'67
85	'2144	684'9201	3	504'9201	'7856	85	84	'7099	128002'38
84	'2059	707'1260	4	467'1260	'7941	84	83	'7015	024'08
84	'1975	729'3235	5	429'3235	'8025	84	85	'6932	045'77
85	'1891	751'5126	6	391'5126	'8109	85	83	'6847	067'46
85	'1806	773'6932	7	353'6932	'8194	83	84	'6764	089'13
83	'1723	795'8655	8	315'8655	'8277	85	84	'6680	110'80
85	'1638	818'0293	9	278'0293	'8362	85	84	'6596	132'46
85	'1553				'8447				
83	'1470	840'1846	10	240'1846	'8530	83	83	'6429	154'11
85	'1385	862'3316	1	202'3316	'8615	85	85	'6344	175'76
84	'1301	884'4701	2	164'4701	'8699	84	83	'6261	197'39
84	'1217	906'6002	3	126'6002	'8783	84	84	'6177	219'02
84	'1133	928'7219	4	088'7219	'8867	84	84	'6093	240'63
85	'1048	950'8352	15	050'8352	'8952	85	84	'6009	262'24
83	'0965	972'9400	6	72012'9400	'9035	83	83	'5926	283'84
85	'0880	126995'0365	7	71975'0365	'9120	85	84	'5842	305'41
84	'0796	127017'1245	8	937'1245	'9204	84	84	'5758	327'02
84	'0712	039'2041	9	899'2041	'9288	84	84	'5674	348'60
84	'0628	061'2753	20	861'2753	'9372	84	83	'5591	370'16
85	'0543	083'3381	1	823'3381	'9457	85	84	'5507	391'72
83	'0460	105'3924	2	785'3924	'9540	83	84	'5423	413'27
85	'0375	127'4384	3	747'4384	'9625	85	83	'5340	434'82
84	'0291	149'4759	5	709'4759	'9709	84	85	'5255	456'35
84	'0207	171'5050	25	671'5050	'9793	84	83	'5172	477'85
84	'0123	193'5257	6	633'5257	'9877	84	84	'5088	499'39
85	'0038	215'5380	7	595'5380	'9962	85	83	'5005	520'90
83	22'0038	237'5418	8	557'5418	37'9962	83	84	'4921	542'40
85	21'9955	259'5373	9	519'5373	38'0045	85	84	'4837	563'86
	'9870				'0130				
85	'9787	281'5243	30	481'5243	'0213	83	83	'4754	585'38
85	'9702	303'5030	1	443'5030	'0298	85	84	'4670	606'85
83	'9619	325'4732	2	405'4732	'0381	83	84	'4586	628'32
85	'9534	347'4351	3	367'4351	'0466	85	84	'4502	649'78
84	'9450	369'3885	4	329'3885	'0550	84	83	'4419	671'23
84	'9366	391'3335	35	291'3335	'0634	84	83	'4336	692'67
84	'9282	413'2701	6	253'2701	'0718	84	85	'4251	714'11
84	'9198	435'1983	7	215'1983	'0802	84	83	'4168	735'53
84	'9114	457'1181	8	177'1181	'0886	84	83	'4085	756'95
84	'9030	479'0295	9	139'0295	'0970	84	84	'4001	778'36
84	'8946	500'9325	40	100'9325	'1054	84	84	'3917	799'76
84	'8862	522'8271	1	062'8271	'1138	84	83	'3834	821'15
84	'8778	544'7133	2	71024'7133	'1222	84	84	'3750	842'53
85	'8693	566'5911	3	70986'5911	'1307	85	84	'3666	863'99
83	'8610	588'4604	4	948'4604	'1390	83	83	'3583	885'27
84	'8526	610'3214	45	910'3214	'1474	84	84	'3499	906'63
84	'8442	632'1740	6	872'1740	'1558	84	83	'3416	927'98
84	'8358	654'0182	7	834'0182	'1642	84	84	'3332	949'32
84	'8274	675'8540	8	795'8540	'1726	84	83	'3249	970'66
84	'8190	697'6814	9	757'6814	'1810	84	84	'3165	128991'98
84	'8106	719'5004	50	719'5004	'1894	84	83	'3082	129013'30
84	'8022	741'3110	1	681'3110	'1978	84	84	'2998	034'60
84	'7938	763'1132	2	643'1132	'2062	84	84	'2914	055'90
84	'7854	784'9070	3	604'9070	'2146	84	83	'2831	077'20
83	'7771	806'6924	4	566'6924	'2229	83	83	'2748	098'48
85	'7686	828'4695	55	528'4695	'2314	85	84	'2664	119'75
84	'7602	850'2381	6	490'2381	'2398	84	83	'2581	141'02
83	'7519	871'9983	7	451'9983	'2481	83	84	'2497	162'28
84	'7435	893'7502	8	413'7502	'2565	84	83	'2414	183'53
85	21'7350	915'4937	9	375'4937	38'2650	85	84	21'2330	204'77
		127937'2287	60	70337'2287					129226'00

	-16°.	Diff.	Δ°.	Δ°.	Diff.	17°.		-17°.	Diff.	Δ°.
0	70337.2287	"	83	83	"	129226.0076	0	68026.0076	"	83
1	298.9554	38.2733	84	84	21.2247	247.2323	1	67987.2323	38.7753	84
2	260.6737	2817	84	84	2163	268.4486	2	948.4486	7837	84
3	222.3836	2901	84	83	2080	289.6566	3	909.6566	7920	83
4	184.0851	2985	83	84	1997	310.8563	4	870.8563	8003	83
5	145.7783	3068	85	84	1913	332.0476	5	832.0476	8087	84
6	107.4630	3153	83	83	1829	353.2305	6	793.2305	8171	83
7	69.1394	3236	84	83	1746	374.4051	7	754.4051	8254	83
8	70030.8074	3320	84	84	1663	395.5714	8	715.5714	8337	84
9	69992.4670	3404	84	83	1579	416.7293	9	676.7293	8421	83
		3488			1496				8504	
10	954.1182	3571	83	83	1413	437.8789	10	637.8789	8587	83
1	915.7611	3656	85	84	1329	459.0202	1	599.0202	8671	84
2	877.3955	3739	83	83	1246	480.1531	2	560.1531	8754	83
3	839.0216	3823	84	83	1163	501.2777	3	521.2777	8837	83
4	800.6393	3907	84	84	1079	522.3940	4	482.3940	8921	84
5	762.2486	3991	84	83	0996	543.5019	5	443.5019	9004	83
6	723.8495	4074	83	84	0912	564.6015	6	404.6015	9088	84
7	685.4421	4158	84	83	0829	585.6927	7	365.6927	9171	83
8	647.0263	4242	84	83	0746	606.7756	8	326.7756	9254	83
9	608.6021	4326	84	83	0663	627.8502	9	287.8502	9337	83
20	570.1695	4409	83	84	0579	648.9165	20	248.9165	9421	84
1	531.7286	4493	84	83	0496	669.9744	1	209.9744	9504	83
2	493.2793	4577	84	83	0413	691.0240	2	171.0240	9587	83
3	454.8216	4660	83	84	0329	712.0653	3	132.0653	9671	84
4	416.3556	4745	85	83	0246	733.0982	4	093.0982	9754	83
5	377.8811	4828	83	83	0163	754.1228	5	054.1228	9837	83
6	339.3983	4912	84	83	0080	775.1391	6	67015.1391	9920	84
7	300.9071	4995	84	84	20.9996	796.1471	7	66976.1471	39.0004	84
8	262.4076	5079	84	83	9913	817.1467	8	937.1467	0087	83
9	223.8997	5163	84	83	9830	838.1380	9	898.1380	0170	83
30	185.3834	5246	83	83	9747	859.1210	30	859.1210	0253	83
1	146.8588	5330	84	84	9663	880.0957	1	820.0957	0337	84
2	108.3258	5414	84	83	9580	901.0620	2	781.0620	0420	83
3	69.7844	5498	84	83	9497	922.0200	3	742.0200	0503	83
4	69031.2346	5581	83	83	9414	942.9697	4	702.9697	0586	83
5	68992.6765	5664	83	84	9331	963.9111	5	663.9111	0669	83
6	954.1101	5749	85	84	9247	129984.8442	6	624.8442	0753	84
7	915.5352	5832	83	82	9165	130005.7689	7	585.7689	0835	82
8	876.9520	5915	83	84	9081	026.6854	8	546.6854	0919	83
9	838.3605	5999	84	83	8998	047.5935	9	507.5935	1002	83
40	799.7606	6083	84	83	8915	068.4933	40	468.4933	1085	83
1	761.1523	6166	83	84	8831	089.3848	1	429.3848	1169	84
2	722.5357	6250	84	82	8749	110.2679	2	390.2679	1251	82
3	683.9107	6334	84	84	8665	131.1428	3	351.1428	1335	84
4	645.2773	6417	83	83	8582	152.0093	4	312.0093	1418	83
45	606.6356	6501	84	82	8500	172.8675	45	272.8675	1500	82
6	567.9855	6584	83	84	8416	193.7175	6	233.7175	1584	84
7	529.3271	6668	84	84	8332	214.5591	7	194.5591	1668	84
8	490.6603	6751	83	82	8250	235.3923	8	155.3923	1750	82
9	451.9852	6835	84	83	8167	256.2173	9	116.2173	1833	83
50	413.3017	6918	83	83	8084	277.0340	50	077.0340	1916	83
1	374.6099	7002	84	83	8001	297.8424	1	66037.8424	1999	84
2	335.9097	7086	84	84	7917	318.6425	2	65998.6425	2083	83
3	297.2011	7169	83	82	7835	339.4342	3	959.4342	2165	82
4	258.1842	7252	83	84	7751	360.2177	4	920.2177	2249	84
55	219.7590	7336	84	82	7669	380.9928	55	880.9928	2331	82
6	181.0254	7419	83	84	7585	401.7597	6	841.7597	2415	84
7	142.2835	7503	83	83	7502	422.5182	7	802.5182	2498	83
8	103.5332	7586	83	82	7420	443.2684	8	763.2684	2580	82
9	64.7746	7670	84	84	7336	464.0104	9	724.0104	2664	84
60	68026.0076			20	7336	130484.7440	60	65684.7440		

Δ° .	Diff.	18° .		-18° .	Diff.	Δ° .	Δ° .	Diff.	19° .
82	"	130484	"	7440	0	65684	"	7440	"
84	20'7254	505'4694	1	645'4694	39'2746	82	83	20'2288	131713'6029
83	7170	526'1864	2	606'1864	'2830	84	82	'2206	733'8317
83	7087	546'8951	3	566'8951	'2913	83	83	'2123	754'0523
84	7005	567'5956	4	527'5956	'2995	82	82	'2041	774'2646
84	6921	588'2877	5	488'2877	'3079	84	82	'1959	794'4687
82	6839	608'9716	6	448'9716	'3161	82	83	'1876	814'6646
83	6756	629'6472	7	409'6472	'3244	83	83	'1793	834'8522
84	6672	650'3144	8	370'3144	'3328	82	82	'1711	855'0311
82	6590	670'9734	9	330'9734	'3410	83	83	'1628	875'2026
83	6507				'3493	83	82	'1546	895'3652
83	6424	691'6241	10	291'6241	'3576	83	82	'1464	915'5206
83	6341	712'2665	1	252'2665	'3659	83	83	'1381	935'6662
83	6258	732'9006	2	212'9006	'3742	83	82	'1299	955'8041
83	6175	753'5264	3	173'5264	'3825	83	83	'1216	975'9342
83	6092	774'1439	4	134'1439	'3908	83	82	'1134	131996'0566
82	6010	794'7531	15	94'7531	'3990	82	82	'1052	132016'1692
84	5926	815'3541	6	055'3541	'4074	84	83	'0969	036'2748
82	5844	835'9467	7	65015'9467	'4156	82	82	'0887	056'3711
83	5761	856'5311	8	64976'5311	'4239	83	82	'0805	076'4602
83	5678	877'1072	9	937'1072	'4322	83	83	'0722	096'5407
83	5595	897'6750	20	897'6750	'4405	83	83	'0639	116'6126
83	5512	918'2345	1	858'2345	'4488	83	81	'0558	136'6764
82	5430	938'7857	2	818'7857	'4570	82	83	'0475	156'7326
84	5346	959'3287	3	779'3287	'4654	84	82	'0393	176'7801
82	5264	130979'8633	4	739'8633	'4736	82	83	'0310	196'8192
83	5181	131000'3897	25	700'3897	'4819	83	81	'0229	216'8502
83	5098	020'9078	6	660'9078	'4902	83	83	'0146	236'8731
82	5016	041'4176	7	621'4176	'4984	82	83	20'0063	256'8876
83	4933	061'9192	8	581'9192	'5067	83	82	19'9981	276'8941
83	4850	082'4125	9	542'4125	'5150	83	82	'9899	296'8921
83	4767	102'8975	30	502'8975	'5233	83	82	'9817	316'8822
82	4685	123'3742	1	463'3742	'5315	82	82	'9735	336'8632
84	4601	143'8427	2	423'8427	'5399	84	83	'9652	356'8371
82	4519	164'3028	3	384'3028	'5481	82	82	'9570	376'8021
82	4437	184'7547	4	344'7547	'5563	82	82	'9488	396'7591
84	4353	205'1984	35	305'1984	'5647	84	82	'9406	416'7081
82	4271	225'6337	6	265'6337	'5729	82	83	'9323	436'6491
83	4188	246'0608	7	226'0608	'5812	83	82	'9241	456'5811
82	4106	266'4796	8	186'4796	'5894	82	82	'9159	476'5951
83	4023	286'8902	9	146'8902	'5977	83	82	'9077	496'4211
83	3940	307'2925	40	107'2925	'6060	83	82	'8995	516'3291
83	3857	327'6865	1	067'6865	'6143	83	83	'8912	536'2281
82	3775	348'0722	2	64028'0722	'6225	82	81	'8831	556'1191
83	3692	368'4497	3	63988'4497	'6308	83	83	'8748	576'0021
83	3609	388'8189	4	948'8189	'6391	83	82	'8666	596'8771
82	3527	409'1798	45	909'1798	'6473	82	82	'8584	615'7441
83	3444	429'5325	6	869'5325	'6556	83	82	'8502	635'6021
82	3362	449'8769	7	829'8769	'6638	82	82	'8420	655'4521
83	3279	470'2131	8	790'2131	'6721	83	83	'8337	675'2941
82	3197	490'5410	9	750'5410	'6803	82	82	'8255	695'1281
84	3113	510'8607	50	710'8607	'6887	84	81	'8174	714'9541
82	3031	531'1720	1	671'1720	'6969	82	83	'8091	734'7711
82	2949	551'4751	2	631'4751	'7051	82	81	'8010	754'5801
83	2866	571'7700	3	591'7700	'7134	83	83	'7927	774'3811
83	2783	592'0566	4	552'0566	'7217	83	82	'7845	794'1742
82	2701	612'3349	55	512'3349	'7299	82	82	'7763	813'9587
82	2619	632'6050	6	472'6050	'7381	82	82	'7681	833'7351
83	2536	652'8669	7	432'8669	'7464	83	82	'7599	853'5931
83	2453	673'1205	8	393'1205	'7547	83	82	'7517	873'2631
82	2371	693'3658	9	353'3658	'7629	82	82	'7435	893'0147
		131713'6029	60	63313'6029					132912'7582

	-19°.	Diff.	Δ°.	Δ°.	Diff.	20°.		-20.	Diff.	Δ°.
00	63313.6029	"	83	83	19.7352	132912.7582	0	60912.7582	"	83
01	273.8317	39.7712	82	81	'7352	932.4934	1	872.4934	40.2648	81
02	234.0523	'7794	83	81	'7271	952.2205	2	832.2205	'2729	81
03	194.2646	'7777	82	83	'7190	971.9395	3	791.9395	'2810	83
04	154.1687	'7959	82	82	'7107	132991.6502	4	751.6502	'2893	82
05	114.6646	'8041	83	82	'7025	133011.3527	5	711.3527	'2975	82
06	074.8522	'8124	83	82	'6943	031.0470	6	671.0470	'3057	82
07	63035.0315	'8207	82	82	'6861	050.7331	7	630.7331	'3139	82
08	62995.2026	'8289	83	82	'6779	070.4110	8	590.4110	'3221	82
09	955.3654	'8372	82	81	'6697	090.0807	9	550.0807	'3303	81
		'8454			'6616				'3384	
10	915.5200	'8536	82	83	'6533	109.7423	10	509.7423		83
11	875.6664	'8619	83	81	'6452	129.3956	1	469.3956	'3467	81
12	835.8045	'8701	82	83	'6369	149.0408	2	429.0408	'3548	83
13	795.9344	'8784	83	81	'6288	168.6777	3	388.6777	'3631	81
14	756.0560	'8866	82	82	'6206	188.3065	4	348.3065	'3712	82
15	716.1694	'8948	82	82	'6124	207.9271	15	307.9271	'3794	82
16	676.2746	'9031	83	82	'6042	227.5395	6	267.5395	'3876	82
17	636.3715	'9113	82	82	'5960	247.1437	7	227.1437	'3958	82
18	596.4602	'9195	82	82	'5878	266.7397	8	186.7397	'4040	82
19	556.5407	'9278	83	81	'5797	286.3275	9	146.3275	'4122	81
									'4203	
20	516.6129	'9361	83	82	'5715	305.9072	20	105.9072		82
21	476.6768	'9442	81	83	'5632	325.4787	1	065.4787	'4285	83
22	436.7326	'9525	82	81	'5551	345.0419	2	60025.0419	'4368	81
23	396.7801	'9607	82	81	'5470	364.5970	3	59984.5970	'4449	81
24	356.8194	'9690	83	83	'5387	384.1440	4	944.1440	'4530	83
25	316.8504	'9771	81	81	'5306	403.6827	25	903.6827	'4613	81
26	276.8733	'9854	83	82	'5224	423.2133	6	863.2133	'4694	82
27	236.8879	39.9937	83	82	'5142	442.7357	7	822.7357	'4776	82
28	196.8942	40.0019	82	81	'5061	462.2499	8	782.2499	'4858	81
29	156.8923	'0101	82	83	'4978	481.7560	9	741.7560	'4939	83
									'5022	
30	116.8822	'0183	82	81	'4897	501.2538	30	701.2538		81
31	076.8639	'0265	82	82	'4815	520.7435	1	660.7435	'5103	82
32	62036.8374	'0348	83	81	'4734	540.2250	2	620.2250	'5185	81
33	61996.8026	'0430	82	83	'4651	559.6984	3	579.6984	'5266	83
34	956.7596	'0512	82	81	'4570	579.1635	4	539.1635	'5349	81
35	916.7084	'0594	82	82	'4489	598.6205	35	498.6205	'5430	82
36	876.6490	'0677	83	82	'4407	618.0694	6	458.0694	'5511	81
37	836.5813	'0759	82	82	'4325	637.5101	7	417.5101	'5593	82
38	796.5054	'0841	82	82	'4243	656.9426	8	376.9426	'5675	82
39	756.4213	'0923	82	82	'4161	676.3669	9	336.3669	'5757	82
									'5839	
40	716.3290	'1005	82	81	'4080	695.7830	40	295.7830		81
41	676.2285	'1088	83	81	'3999	715.1910	1	255.1910	'5920	81
42	636.1197	'1169	81	82	'3917	734.5909	2	214.5909	'6001	82
43	596.0028	'1252	82	82	'3835	753.9826	3	173.9826	'6083	82
44	555.8776	'1334	82	82	'3753	773.3661	4	133.3661	'6165	82
45	515.7442	'1416	82	81	'3672	792.7414	45	092.7414	'6247	81
46	475.6026	'1498	82	82	'3590	812.1086	6	052.1086	'6328	82
47	435.4528	'1580	82	81	'3509	831.4676	7	59011.4676	'6410	81
48	395.2948	'1663	83	82	'3427	850.8185	8	58970.8185	'6491	82
49	355.1285	'1745	82	81	'3346	870.1612	9	930.1612	'6573	81
									'6654	
50	314.9540	'1826	81	82	'3264	889.4958	50	889.4958		82
51	274.7714	'1909	83	82	'3182	908.8222	1	848.8222	'6736	82
52	234.5805	'1990	81	81	'3101	928.1404	2	808.1404	'6818	81
53	194.3815	'2073	82	81	'3020	947.4505	3	767.4505	'6899	81
54	154.1742	'2155	82	83	'2937	966.7525	4	726.7525	'6980	83
55	113.9587	'2237	82	81	'2856	133986.0462	55	686.0462	'7063	81
56	073.7350	'2319	82	81	'2775	134005.3318	6	645.3318	'7144	81
57	61033.5031	'2401	82	81	'2694	024.6093	7	604.6093	'7225	81
58	60993.2630	'2483	82	82	'2612	043.8787	8	563.8787	'7306	82
59	953.0147	'2565	82	82	'2530	063.1399	9	523.1399	'7388	82
60	60912.7582	40.2565		19.2530	134082.3929	60	58482.3929	40.7470		

Δ°	Diff.	21°		-21°	Diff.	Δ°	Δ°	Diff.	22°
81	"	134082'3929	0	58482'3929	"	81	82	"	135222'699
82	19'2449	101'6378	1	441'6378	40'7551	82	80	18'7577	241'4561
81	'2367	120'8745	2	400'8745	'7633	81	82	'7497	260'2061
81	'2286	140'1031	3	360'1031	'7714	81	80	'7415	278'9480
82	'2205	159'3236	4	319'3236	'7795	82	81	'7335	297'6811
82	'2123	178'5359	5	278'5359	'7877	82	80	'7254	316'4060
80	'2041	197'7400	6	237'7400	'7959	80	82	'7174	335'1241
82	'1961	216'9361	7	196'9361	'8039	82	81	'7092	353'8331
82	'1879	236'1240	8	156'1240	'8121	82	80	'7011	372'5346
81	'1797	255'3037	9	115'3037	'8203	81	81	'6931	391'2271
	'1716				'8284			'6850	
81	'1635	274'4753	10	074'4753	'8365	81	81	'6769	409'9127
82	'1553	293'6388	1	58033'6388	'8447	82	81	'6688	428'5896
81	'1472	312'7941	2	57992'7941	'8528	81	81	'6607	447'2581
82	'1390	331'9413	3	951'9413	'8610	82	80	'6527	465'9191
80	'1310	351'0803	4	911'0803	'8690	80	81	'6446	484'5711
82	'1228	370'2113	15	870'2113	'8772	82	81	'6365	503'2161
82	'1146	389'3341	6	829'3341	'8854	82	81	'6284	521'8526
81	'1065	408'4487	7	788'4487	'8935	81	81	'6203	540'4811
81	'0984	427'5552	8	747'5552	'9016	81	80	'6123	559'1011
81	'0903	446'6536	9	706'6536	'9097	81	81	'6042	577'7131
81	'0822	465'7439	20	665'7439	'9178	81	80	'5962	596'3181
82	'0740	484'8261	1	624'8261	'9260	82	82	'5880	614'9141
81	'0659	503'9001	2	583'9001	'9341	81	80	'5800	633'5021
82	'0577	522'9660	3	542'9660	'9423	82	81	'5719	652'0821
80	'0497	542'0237	4	502'0237	'9503	80	80	'5639	670'6541
82	'0415	561'0734	25	461'0734	'9585	82	81	'5558	689'2181
81	'0334	580'1149	6	420'1149	'9666	81	81	'5477	707'7731
82	'0252	599'1483	7	379'1483	'9748	82	80	'5397	726'3216
80	'0172	618'1735	8	338'1735	'9828	80	81	'5316	744'8611
82	'0090	637'1907	9	297'1907	'9910	82	81	'5235	763'3921
81	19'0009	656'1997	30	256'1997	40'9991	81	81	'5154	781'9161
82	18'9928	675'2006	1	215'2006	41'0072	82	80	'5074	800'4311
80	'9846	694'1934	2	174'1934	'0154	80	80	'4994	818'9391
82	'9766	713'1780	3	133'1780	'0234	82	81	'4913	837'4381
81	'9684	732'1546	4	092'1546	'0316	81	81	'4832	855'9291
81	'9603	751'1230	35	051'1230	'0397	81	80	'4752	874'4131
81	'9522	770'0833	6	57010'0833	'0478	81	81	'4671	892'8881
81	'9441	789'0355	7	56969'0355	'0559	81	81	'4590	911'3551
81	'9360	807'9796	8	927'9796	'0640	81	80	'4510	929'8141
81	'9279	826'9156	9	886'9156	'0721	81	80	'4430	948'2651
81	'9198	845'8435	40	845'8435	'0802	81	81	'4349	966'7081
82	'9116	864'7633	1	804'7633	'0884	82	81	'4268	135985'143
80	'9036	883'6749	2	763'6749	'0964	80	80	'4183	136003'570
82	'8954	902'5785	3	722'5785	'1046	82	80	'4108	021'988
81	'8873	921'4739	4	681'4739	'1127	81	81	'4027	040'399
80	'8793	940'3612	45	640'3612	'1207	80	81	'3946	058'802
82	'8711	959'2405	6	599'2405	'1289	82	80	'3866	077'197
81	'8630	978'1116	7	558'1116	'1370	81	80	'3786	095'583
81	'8549	134996'9746	8	516'9746	'1451	81	81	'3705	113'962
81	'8468	135015'8295	9	475'8295	'1532	81	80	'3625	132'332
81	'8387	034'6763	50	434'6763	'1613	81	81	'3544	150'695
81	'8306	053'5150	1	393'5150	'1694	81	81	'3463	169'049
80	'8226	072'3456	2	352'3456	'1774	80	79	'3384	187'395
82	'8144	091'1682	3	311'1682	'1856	82	81	'3303	205'734
81	'8063	109'9826	4	269'9826	'1937	81	80	'3223	224'064
81	'7982	128'7889	55	228'7889	'2018	81	81	'3142	242'386
81	'7901	147'5871	6	187'5871	'2099	81	80	'3062	260'701
80	'7821	166'3772	7	146'3772	'2179	80	81	'2981	279'007
82	'7739	185'1593	8	105'1593	'2261	82	80	'2901	297'305
80	18'7659	203'9332	9	063'9332	'2341	80	80	'2821	315'595
		135222'6991	60	56022'6991					136333'877

	-22° .	Diff.	Δ° .	Δ° .	Diff.	23° .		-23° .	Diff.	Δ° .
0	56022.6991	"	82	80	"	136333.8776	0	53533.8776	"	80
1	55981.4568	41.2423	80	81	18.2741	352.1517	1	492.1517	41.7259	81
2	940.2065.	'2503	82	80	'2660	370.4177	2	450.4177	'7340	81
3	898.9480.	'2585	80	81	'2580	388.6757	3	408.6757	'7420	81
4	857.6815	'2665	81	79	'2499	406.9256	4	366.9256	'7501	79
5	816.4069	'2746	80	81	'2420	425.1676	5	325.1676	'7580	81
6	775.1243	'2826	82	81	'2339	443.4015	6	283.4015	'7661	81
7	733.8335.	'2908	81	79	'2258	461.6273	7	241.6273	'7742	79
8	692.5346	'2989	80	81	'2179	479.8452	8	199.8452	'7821	81
9	651.2277	'3069	81	80	'2098	498.0550	9	158.0550	'7902	80
		'3150			'2018				'7982	
10	609.9127	'3231	81	80	'1938	516.2568	10	116.2568	'8062	80
1	568.5896	'3312	81	81	'1857	534.4506	1	074.4506	'8143	81
2	527.2584	'3393	81	79	'1778	552.6363	2	53032.6363	'8222	79
3	485.9191	'3473	80	81	'1697	570.8141	3	52990.8141	'8303	81
4	444.5718	'3554	81	80	'1617	588.9838	4	948.9838	'8383	80
15	403.2164	'3635	81	81	'1536	607.1455.	15	907.1455.	'8464	81
6	361.8529	'3716	81	79	'1457	625.2991	6	865.2991	'8543	79
7	320.4813	'3797	81	81	'1376	643.4448	7	823.4448	'8624	79
8	279.1016	'3877	80	79	'1297	661.5824	8	781.5824	'8703	81
9	237.7139	'3958	81	81	'1216	679.7121	9	739.7121	'8784	81
20	196.3181	'4038	80	80	'1136	697.8337	20	697.8337	'8864	80
1	154.9143	'4120	82	80	'1056	715.9473	1	655.9473	'8944	80
2	113.5023	'4200	80	80	'0976	734.0529	2	614.0529	'9024	80
3	072.0823	'4281	81	81	'0895	752.1505.	3	572.1505.	'9105	81
4	55030.6542	'4361	80	79	'0816	770.2400	4	530.2400	'9184	79
25	54989.2181	'4442	81	81	'0735	788.3216	25	488.3216	'9265	81
6	947.7739	'4523	81	79	'0656	806.3951	6	446.3951	'9344	79
7	906.3216	'4603	81	80	'0575	824.4607	7	404.4607	'9425	81
8	864.8613	'4684	81	80	'0495	842.5182	8	362.5182	'9505	80
9	823.3929	'4765	81	79	'0416	860.5677	9	320.5677	'9584	79
30	781.9164	'4846	81	81	'0335	878.6093	30	278.6093	'9665	81
1	740.4318	'4926	80	80	'0255	896.6428	1	236.6428	'9745	80
2	698.9392	'5006	80	79	'0176	914.6683	2	194.6683	'9824	79
3	657.4386	'5087	81	81	'0095	932.6859	3	152.6859	'9905	81
4	615.9299	'5168	81	80	'0015	950.6954	4	110.6954	'9985	80
35	574.4131	'5248	80	80	'9856	968.6969	35	068.6969	'41.9985	80
6	532.8883	'5329	81	79	17.9935	136986.6904	6	52026.6904	'0144	79
7	491.3554	'5410	81	81	'9856	137004.6760	7	51984.6760	'0225	81
8	449.8144	'5490	80	80	'9775	022.6535.	8	942.6535.	'0305	80
9	408.2654	'5570	80	79	'9695	040.6230	9	900.6230	'0384	79
					'9616					
40	366.7084	'5651	81	81	'9535	058.5846	40	858.5846	'0465	81
1	325.1433	'5732	81	79	'9456	076.5381	1	816.5381	'0544	79
2	283.5701	'5812	80	80	'9376	094.4837	2	774.4837	'0624	80
3	241.9889	'5892	80	80	'9296	112.4213	3	732.4213	'0704	80
4	200.3997	'5973	81	80	'9216	130.3509	4	690.3509	'0784	80
45	158.8024	'6054	81	80	'9136	148.2725.	45	648.2725.	'0864	80
6	117.1970	'6134	80	80	'9056	166.1861	6	606.1861	'0944	80
7	075.5836	'6214	80	80	'8976	184.0917	7	564.0917	'1024	80
8	54033.9622	'6295	81	80	'8896	201.9893	8	521.9893	'1104	80
9	53992.3327	'6375	80	79	'8817	219.8789	9	479.8789	'1183	79
50	950.6952	'6456	81	80	'8737	237.7606	50	437.7606	'1263	80
1	909.0496	'6537	81	80	'8657	255.6343	1	395.6343	'1343	80
2	867.3959	'6616	79	80	'8577	273.5000	2	353.5000	'1423	80
3	825.7343	'6697	81	79	'8498	291.3577	3	311.3577	'1502	79
4	784.0646	'6777	80	81	'8417	309.2075.	4	269.2075.	'1583	81
55	742.3869	'6858	81	79	'8338	327.0492	55	227.0492	'1662	79
6	700.7011	'6938	80	80	'8258	344.8830	6	184.8830	'1742	80
7	659.0073	'7019	81	79	'8179	362.7088	7	142.7088	'1821	79
8	617.3054	'7099	80	81	'8098	380.5267	8	100.5267	'1902	81
9	575.5955	'7179	80	79	'8019	398.3365	9	058.3365	'1981	79
60	53533.8776					137416.1384	60	51016.1384		

Δ°.	Diff.	24°.		-24°.	Diff.	Δ°.	Diff.	25°.
80	"	137416''1384	0	51016''1384	"	80	"	138469''7000
79	17'7939	433'9323	1	50973'9323	42'2061	79	17'3175	487'0175
81	'7860	451'7183	2	931'7183	'2140	81	'3096	504'3271
79	'7779	469'4962	3	889'4962	'2221	79	'3017	521'6288
79	'7700	487'2662	4	847'2662	'2300	79	'2938	538'9226
81	'7621	505'0283	5	805'0283	'2379	81	'2859	556'2081
79	'7540	522'7823	6	762'7823	'2460	79	'2779	573'4864
79	'7461	540'5284	7	720'5284	'2539	79	'2701	590'7565
80	'7382	558'2666	8	678'2666	'2618	80	'2622	608'0187
80	'7302	575'9968	9	635'9968	'2698	80	'2542	625'2729
	'7222				'2778		'2464	
80	'7142	593'7190	10	593'7190	'2858	80	'2385	642'5193
79	'7063	611'4332	1	551'4332	'2937	79	'2305	659'7578
80	'6983	629'1395	2	509'1395	'3017	80	'2227	676'9883
79	'6904	646'8378	3	466'8378	'3096	79	'2148	694'2110
80	'6824	664'5282	4	424'5282	'3176	80	'2069	711'4258
79	'6745	682'2106	15	382'2106	'3255	79	'1990	728'6327
80	'6665	699'8851	6	339'8851	'3335	80	'1911	745'8317
80	'6585	717'5516	7	297'5516	'3415	79	'1832	763'0228
79	'6506	735'2101	8	255'2101	'3494	79	'1753	780'2060
80	'6426	752'8607	9	212'8607	'3574	80	'1674	797'3813
79	'6347	770'5033	20	170'5033	'3653	79	'1595	814'5487
80	'6268	788'1380	1	128'1380	'3732	79	'1517	831'7082
80	'6188	805'7648	2	085'7648	'3812	80	'1438	848'8599
80	'6108	823'3836	3	043'3836	'3892	80	'1359	866'0037
79	'6029	840'9944	4	50000'9944	'3971	79	'1280	883'1396
79	'5950	858'5973	25	49958'5973	'4050	79	'1201	900'2676
80	'5870	876'1923	6	916'1923	'4130	80	'1122	917'3877
80	'5790	893'7793	7	873'7793	'4210	80	'1044	934'4999
79	'5711	911'3583	8	831'3583	'4289	79	'0965	951'6043
79	'5632	928'9294	9	788'9294	'4368	79	'0886	968'7008
79	'5553	946'4926	30	746'4926	'4447	79	'0807	138985'7894
80	'5473	964'0479	1	704'0479	'4527	80	'0729	139002'8701
80	'5393	981'5952	2	661'5952	'4607	80	'0650	019'9430
79	'5314	137999'1345	3	619'1345	'4686	79	'0571	037'0080
79	'5235	138016'6659	4	576'6659	'4765	79	'0492	054'0651
80	'5155	034'1894	35	534'1894	'4845	80	'0414	071'1143
79	'5076	051'7049	6	491'7049	'4924	79	'0335	088'1557
79	'4997	069'2125	7	449'2125	'5003	79	'0256	105'1892
79	'4918	086'7122	8	406'7122	'5082	79	'0177	122'2148
80	'4838	104'2040	9	364'2040	'5162	80	'0099	139'2325
80	'4758	121'6878	40	321'6878	'5242	80	'0020	156'2424
78	'4680	139'1636	1	279'1636	'5320	78	16'9942	173'2444
80	'4600	156'6316	2	236'6316	'5400	80	'9863	190'2386
79	'4521	174'0916	3	194'0916	'5479	79	'9784	207'2249
79	'4442	191'5437	4	151'5437	'5558	79	'9706	224'2033
80	'4362	208'9879	45	108'9879	'5638	80	'9627	241'1739
78	'4284	226'4241	6	066'4241	'5716	78	'9549	258'1366
80	'4204	243'8525	7	49023'8525	'5796	80	'9470	275'0915
80	'4124	261'2729	8	48981'2729	'5876	80	'9391	292'0385
78	'4046	278'6853	9	938'6853	'5954	78	'9313	308'9776
80	'3966	296'0899	50	896'0899	'6034	80	'9234	325'9089
79	'3887	313'4865	1	853'4865	'6113	79	'9156	342'8323
79	'3808	330'8752	2	810'8752	'6192	79	'9077	359'7479
79	'3729	348'2560	3	768'2560	'6271	79	'8999	376'6556
79	'3650	365'6289	4	725'6289	'6350	79	'8920	393'5555
80	'3570	382'9939	55	682'9939	'6430	80	'8842	410'4475
78	'3492	400'3509	6	640'3509	'6508	78	'8763	427'3317
80	'3412	417'7001	7	597'7001	'6588	80	'8685	444'2080
79	'3333	435'0413	8	555'0413	'6667	79	'8606	461'0765
79	17'3254	452'3746	9	512'3746	'6746	79	'8528	477'9371
		138469'7000	60	48469'7000				139494'7899

	-25°.	Diff.	Δ°.	Δ°.	Diff.	26°.		-26°.	Diff.	Δ°.
1	48469.7000	"			"		1	45894.7899	"	
1	427.0175	42.6825	79	78	16.8450	139494.7899	0	851.6349	43.1550	78
2	384.3271	.6904	79	79	.8371	511.6349	1	808.4720	.1629	79
3	341.6288	.6983	79	79	.8292	528.4720	2	765.3012	.1708	79
4	298.9226	.7062	79	78	.8214	545.3012	3	722.1226	.1786	78
5	256.2085.	.7141	80	78	.8136	562.1226	4	678.9362	.1864	79
6	213.4864	.7221	80	77	.8057	578.9362	5	635.7419	.1943	79
7	170.7565.	.7299	79	79	.7980	595.7419	6	592.5399	.2020	77
8	128.0187	.7378	80	79	.7901	612.5399	7	549.3300	.2099	79
9	085.2729	.7458	78	78	.7822	629.3300	8	506.1122	.2178	78
		.7536			.7744	646.1122	9		.2256	
10	48042.5193	.7615	79	77	.7665	662.8866	10	462.8866	.2335	79
1	47999.7578	.7695	80	77	.7588	679.6531	1	419.6531	.2412	77
2	956.9883	.7773	78	78	.7509	696.4119	2	376.4119	.2491	79
3	914.2110	.7852	79	78	.7431	713.1628	3	333.1628	.2569	78
4	871.4258	.7931	79	79	.7352	729.9059	4	289.9059	.2648	79
15	828.6327	.8010	79	78	.7274	746.6411	15	246.6411	.2726	78
6	785.8317	.8089	79	78	.7196	763.3685	6	203.3685	.2804	78
7	743.0228	.8168	79	78	.7118	780.0881	7	160.0881	.2882	78
8	700.2060	.8247	79	78	.7040	796.7999	8	116.7999	.2960	78
9	657.3813	.8326	79	79	.6961	813.5039	9	073.5039	.3039	79
20	614.5487	.8405	78	78	.6883	830.2000	20	45030.2000	.3117	78
1	571.7082	.8483	79	78	.6805	846.8883	1	44986.8883	.3195	78
2	528.8599	.8562	79	78	.6727	863.5688	2	943.5688	.3273	78
3	486.0037	.8641	79	79	.6648	880.2415	3	900.2415	.3352	79
4	443.1396	.8720	79	77	.6571	896.9063	4	856.9063	.3429	77
25	400.2676	.8799	79	79	.6492	913.5634	25	813.5634	.3508	79
6	357.3877	.8878	79	78	.6414	930.2126	6	770.2126	.3586	78
7	314.4999	.8956	78	78	.6336	946.8540	7	726.8540	.3664	78
8	271.6043	.9035	79	78	.6258	963.4876	8	683.4876	.3742	78
9	228.7008	.9114	79	78	.6180	980.1134	9	640.1134	.3820	78
30	185.7894	.9193	79	79	.6101	139996.7314	30	596.7314	.3899	79
1	142.8701	.9271	78	77	.6024	140013.3415	1	553.3415	.3976	77
2	099.9430	.9350	79	78	.5945	029.9439	2	509.9439	.4055	79
3	057.0080	.9429	79	78	.5867	046.5384	3	466.5384	.4133	77
4	47014.0651	.9508	79	77	.5790	063.1251	4	423.1251	.4210	77
35	46971.1143	.9586	78	79	.5711	079.7041	35	379.7041	.4289	79
6	928.1557	.9665	79	78	.5633	096.2752	6	336.2752	.4367	78
7	885.1892	.9744	79	78	.5555	112.8385	7	292.8385	.4445	78
8	842.2148	.9823	79	77	.5478	129.3940	8	249.3940	.4522	77
9	799.2325	.9901	78	79	.5399	145.9418	9	205.9418	.4601	79
40	756.2424	.9980	79	78	.5321	162.4817	40	162.4817	.4679	78
1	713.2444	43.0058	78	77	.5244	179.0138	1	119.0138	.4756	77
2	670.2386	.0137	79	79	.5165	195.5382	2	075.5382	.4835	79
3	627.2249	.0216	79	78	.5087	212.0547	3	44032.0547	.4913	78
4	584.2033	.0294	78	77	.5010	228.5634	4	43988.5634	.4990	77
45	541.1739	.0373	79	77	.4931	245.0644	45	945.0644	.5069	79
6	498.1366	.0451	78	79	.4854	261.5575	6	901.5575	.5146	77
7	455.0915.	.0530	79	78	.4776	278.0429	7	858.0429	.5224	78
8	412.0385.	.0609	79	79	.4697	294.5205.	8	814.5205.	.5303	79
9	368.9776	.0687	78	77	.4620	310.9902	9	770.9902	.5380	77
50	325.9089	.0766	79	78	.4542	327.4522	50	727.4522	.5458	78
1	282.8323	.0844	78	78	.4464	343.9064	1	683.9064	.5536	78
2	239.7479	.0923	79	77	.4387	360.3528	2	640.3528	.5613	77
3	196.6556	.1001	78	79	.4308	376.7915.	3	596.7915.	.5692	79
4	153.5555.	.1080	79	77	.4231	393.2223	4	553.2223	.5769	77
55	110.4475.	.1158	78	78	.4153	409.6454	55	509.6454	.5847	78
6	067.3317	.1237	79	78	.4075	426.0607	6	466.0607	.5925	78
7	46024.2080	.1315	78	78	.3997	442.4682	7	422.4682	.6003	78
8	45981.0765.	.1394	79	77	.3920	458.8679	8	378.8679	.6080	77
9	937.9371	.1472	78	79	16.3841	475.2599	9	335.2599	.6159	79
60	45894.7899					140491.6440	60	43291.6440		

Δ° .	Diff.	27° .	'	-27° .	Diff.	Δ° .	Δ° .	Diff.	28° .
77	"	140491'6440	0	43291'6440	"	77	77	"	141460'5071
77	16'3764	508'0204	1	248'0204	43'6236	77	77	15'9120	476'4191
77	'3687	524'3891	2	204'3891	'6313	77	77	'9043	492'3234
79	'3608	540'7499	3	160'7499	'6392	79	77	'8966	508'2200
77	'3531	557'1030	4	117'1030	'6469	77	77	'8889	524'1089
78	'3453	573'4483	5	073'4483	'6547	78	77	'8812	539'9901
77	'3375	589'7858	6	43029'7858	'6625	77	77	'8735	555'8636
77	'3298	606'1156	7	42986'1156	'6702	77	78	'8658	571'7294
78	'3220	622'4376	8	942'4376	'6780	78	76	'8580	587'5874
77	'3142	638'7518	9	898'7518	'6858	77	77	'8504	603'4378
77	'3065				'6935			'8427	
78	'2987	655'0583	10	855'0583	'7013	78	77	'8350	619'2805
77	'2910	671'3570	1	811'3570	'7090	77	76	'8274	635'1155
79	'2831	687'6480	2	767'6480	'7169	79	78	'8196	650'9429
77	'2754	703'9311	3	723'9311	'7246	77	77	'8119	666'7625
77	'2677	720'2065	4	680'2065	'7323	77	76	'8043	682'5744
78	'2599	736'4742	15	636'4742	'7401	78	77	'7966	698'3787
77	'2522	752'7341	6	592'7341	'7478	77	77	'7889	714'1753
78	'2444	768'9863	7	548'9863	'7556	78	77	'7812	729'9642
78	'2366	785'2307	8	505'2307	'7634	78	77	'7735	745'7454
77	'2289	801'4673	9	461'4673	'7711	77	77	'7658	761'5189
78	'2211	817'6962	20	417'6962	'7789	78	76	'7582	777'2847
77	'2134	833'9173	1	373'9173	'7866	77	78	'7504	793'0429
78	'2056	850'1307	2	330'1307	'7944	78	76	'7428	808'7933
77	'1979	866'3363	3	286'3363	'8021	77	77	'7351	824'5361
78	'1901	882'5342	4	242'5342	'8099	78	76	'7275	840'2712
77	'1824	898'7243	25	198'7243	'8176	77	78	'7197	855'9987
78	'1746	914'9067	6	154'9067	'8254	78	76	'7121	871'7184
77	'1669	931'0813	7	111'0813	'8331	77	77	'7044	887'4305
77	'1592	947'2482	8	067'2482	'8408	77	76	'6968	903'1349
78	'1514	963'4074	9	42023'4074	'8486	78	78	'6890	918'8317
77	'1437	979'5588	30	41979'5588	'8563	77	76	'6814	934'5207
78	'1359	140995'7025	1	935'7025	'8641	78	76	'6738	950'2021
77	'1282	141011'8384	2	891'8384	'8718	77	78	'6660	965'8759
77	'1205	027'9666	3	847'9666	'8795	77	76	'6584	981'5419
78	'1127	044'0871	4	804'0871	'8873	78	76	'6508	141997'2003
77	'1050	060'1998	35	760'1998	'8950	77	77	'6431	142012'8511
78	'0972	076'3048	6	716'3048	'9028	78	77	'6354	028'4942
76	'0896	092'4020	7	672'4020	'9104	76	77	'6277	044'1296
78	'0818	108'4916	8	628'4916	'9182	78	76	'6201	059'7573
78	'0740	124'5734	9	584'5734	'9260	78	77	'6124	075'3774
77	'0663	140'6474	40	540'6474	'9337	77	76	'6048	090'9898
77	'0586	156'7137	1	496'7137	'9414	77	76	'5972	106'5946
77	'0509	172'7723	2	452'7723	'9491	77	78	'5894	122'1918
77	'0432	188'8232	3	408'8232	'9568	77	76	'5818	137'7812
78	'0354	204'8664	4	364'8664	'9646	78	76	'5742	153'3630
77	'0277	220'9018	45	320'9018	'9723	77	77	'5665	168'9372
77	'0200	236'9295	6	276'9295	'9800	77	76	'5589	184'5037
78	'0122	252'9495	7	232'9495	'9878	78	77	'5512	200'0626
77	16'0045	268'9617	8	188'9617	'9955	77	76	'5436	215'6138
76	15'9969	284'9662	9	144'9662	'0031	76	77	'5359	231'1574
78	'9891	300'9631	50	100'9631	'0109	78	77	'5282	246'6933
77	'9814	316'9522	1	056'9522	'0186	77	76	'5206	262'2215
77	'9737	332'9336	2	41012'9336	'0263	77	76	'5130	277'7421
78	'9659	348'9073	3	40968'9073	'0341	78	76	'5054	293'2551
77	'9583	364'8732	4	924'8732	'0417	77	77	'4978	308'7605
78	'9505	380'8315	55	880'8315	'0495	78	77	'4901	324'2582
77	'9428	396'7820	6	836'7820	'0572	77	76	'4824	339'7483
76	'9351	412'7248	7	792'7248	'0649	76	76	'4748	355'2307
78	'9275	428'6599	8	748'6599	'0725	78	76	'4672	370'7055
15'9197	444'5874	9	704'5874	'0803		15'4595		'4595	386'1727
	141460'5071	60	40660'5071						142401'6322

	-29° .	Diff.	Δ° .	Δ° .	Diff.	29° .		-29° .	Diff.	Δ° .
0	40660'5071	"			"	142401'6322	0	38001'6322	"	
1	616'1191	44'0880	77	76	15'4519	417'0841	1	37957'0841	44'5481	76
2	572'3234	'0957	77	76	'4443	432'5284	2	912'5284	'5557	76
3	528'2200	'1034	77	76	'4366	447'9650	3	867'9650	'5634	76
4	484'1089	'1111	77	76	'4290	463'3940	4	823'3940	'5710	76
5	439'9901	'1188	77	77	'4214	478'8154	5	778'8154	'5786	77
6	395'8636	'1265	77	75	'4137	494'2291	6	734'2291	'5863	75
7	351'7294	'1342	78	77	'4062	509'6353	7	689'6353	'5938	77
8	307'5874	'1420	76	76	'3985	525'0338	8	645'0338	'6015	76
9	263'4378	'1496	77	77	'3909	540'4247	9	600'4247	'6091	77
		'1573			'3832				'6168	
10	219'2805	'1650	77	76	'3756	555'8079	10	555'8079	'6244	76
1	175'1155	'1726	76	75	'3681	571'1835	1	511'1835	'6319	75
2	130'9429	'1804	78	77	'3604	586'5516	2	466'5516	'6396	79
3	86'7625	'1881	77	76	'3528	601'9120	3	421'9120	'6472	76
4	4042'5744	'1957	76	77	'3451	617'2648	4	377'2648	'6549	77
15	39998'3787	'2034	77	75	'3376	632'6099	15	332'6099	'6624	75
6	954'1753	'2111	77	77	'3299	647'9475	6	287'9475	'6701	77
7	909'9642	'2188	77	75	'3224	663'2774	7	243'2774	'6776	75
8	865'7454	'2265	77	77	'3147	678'5998	8	198'5998	'6853	77
9	821'5189	'2342	77	76	'3071	693'9145	9	153'9145	'6929	76
20	777'2847	'2418	76	76	'2995	709'2216	20	109'2216	'7005	76
1	733'0429	'2496	78	76	'2919	724'5211	1	064'5211	'7081	76
2	688'7933	'2572	76	76	'2843	739'8130	2	37019'8130	'7157	76
3	644'5361	'2649	77	76	'2767	755'0973	3	36975'0973	'7233	76
4	600'2712	'2725	76	76	'2691	770'3740	4	930'3740	'7309	76
25	555'9987	'2803	78	77	'2614	785'6431	25	885'6431	'7386	77
6	511'7184	'2879	76	75	'2539	800'9045	6	840'9045	'7461	75
7	467'4305	'2956	77	76	'2463	816'1584	7	796'1584	'7537	76
8	423'1349	'3032	76	76	'2387	831'4047	8	751'4047	'7613	76
9	378'8317	'3110	78	76	'2311	846'6434	9	706'6434	'7689	76
30	334'5207	'3186	76	76	'2235	861'8745	30	661'8745	'7765	76
1	290'2021	'3262	76	76	'2159	877'0980	1	617'0980	'7841	76
2	245'8759	'3340	78	76	'2083	892'3139	2	572'3139	'7917	76
3	201'5419	'3416	76	76	'2007	907'5222	3	527'5222	'7993	76
4	157'2003	'3492	76	76	'1931	922'7229	4	482'7229	'8069	76
35	112'8511	'3569	77	75	'1856	937'9160	35	437'9160	'8144	75
6	068'4942	'3646	77	77	'1779	953'1016	6	393'1016	'8221	77
7	39024'1296	'3723	77	75	'1704	968'2795	7	348'2795	'8296	75
8	38979'7573	'3799	76	76	'1628	983'4499	8	303'4499	'8372	76
9	935'3774	'3876	77	76	'1552	142998'6127	9	258'6127	'8448	76
40	890'9898	'3952	76	76	'1476	143013'7679	40	213'7679	'8524	76
1	846'5946	'4028	76	76	'1400	028'9155	1	168'9155	'8600	76
2	802'1918	'4106	78	75	'1325	044'0555	2	124'0555	'8675	75
3	757'7812	'4182	76	77	'1248	059'1880	3	079'1880	'8752	77
4	713'3630	'4258	76	75	'1173	074'3128	4	36034'3128	'8827	75
45	668'9372	'4335	77	76	'1097	089'4301	45	35989'4301	'8903	76
6	624'5937	'4411	76	75	'1022	104'5398	6	944'5398	'8978	75
7	580'0626	'4488	77	77	'0945	119'6420	7	899'6420	'9055	77
8	535'6138	'4564	76	75	'0870	134'7365	8	854'7365	'9130	75
9	491'1574	'4641	77	75	'0795	149'8235	9	809'8235	'9205	75
50	446'6933	'4718	77	77	'0718	164'9030	50	764'9030	'9282	77
1	402'2215	'4794	76	75	'0643	179'9748	1	719'9748	'9357	75
2	357'7421	'4870	76	76	'0567	195'0391	2	675'0391	'9433	76
3	313'2551	'4946	76	75	'0492	210'0958	3	630'0958	'9508	75
4	268'7605	'5023	77	76	'0416	225'1450	4	585'1450	'9584	76
55	224'2582	'5099	76	76	'0340	240'1866	55	540'1866	'9660	76
6	179'7485	'5176	77	76	'0264	255'2206	6	495'2206	'9736	76
7	135'2307	'5252	76	75	'0189	270'2470	7	450'2470	'9811	75
8	090'7055	'5328	76	75	'0114	285'2659	8	405'2659	'9886	75
9	046'1727		77	76	'0038	300'2773	9	360'2773	'9962	76
60	38001'6322	44'5405				143315'2811	60	35315'2811		

Δ°	Diff.	30°	'	-30°	Diff.	Δ°	Δ°	Diff.	31°
76	"	143315'2811	0	35315'2811	"	76	75	"	144201'723
76	14'9962	330'2773	1	270'2773	45'0038	76	75	14'5451	216'268
75	'9886	345'2659	2	225'2659	'0114	75	74	'5376	230'806
75	'9811	360'2470	3	180'2470	'0189	75	75	'5362	245'336
75	'9736	375'2206	4	135'2206	'0264	75	75	'5227	259'859
76	'9660	390'1866	5	090'1866	'0340	76	75	'5152	274'374
75	'9585	405'1451	6	045'1451	'0415	75	75	'5077	288'888
76	'9509	420'0960	7	35000'0960	'0491	76	74	'5003	303'382
75	'9433	435'0393	8	34955'0393	'0567	75	75	'4928	317'875
75	'9358	449'9751	9	909'9751	'0642	75	74	'4853	332'360
75	'9283				'0717	75		'4779	
76	'9207	464'9034	10	864'9034	'0793	76	75	'4704	346'838
75	'9132	479'8241	1	819'8241	'0868	75	75	'4629	361'308
76	'9056	494'7373	2	774'7373	'0944	76	74	'4555	375'771
75	'8981	509'6429	3	729'6429	'1019	75	75	'4480	390'227
75	'8906	524'5410	4	684'5410	'1094	75	75	'4405	404'675
76	'8830	539'4316	15	639'4316	'1170	76	74	'4331	419'115
76	'8754	554'3146	6	594'3146	'1246	76	75	'4256	433'548
74	'8680	569'1900	7	549'1900	'1320	74	75	'4181	447'974
76	'8604	584'0580	8	504'0580	'1396	76	74	'4107	462'392
76	'8528	598'9184	9	458'9184	'1472	76	74	'4033	476'803
74	'8454	613'7712	20	413'7712	'1546	74	75	'3958	491'206
76	'8378	628'6166	1	368'6166	'1622	76	75	'3883	505'602
75	'8303	643'4544	2	323'4544	'1697	75	74	'3809	519'990
76	'8227	658'2847	3	278'2847	'1773	76	75	'3734	534'371
75	'8152	673'1074	4	233'1074	'1848	75	74	'3660	548'744
75	'8077	687'9226	25	187'9226	'1923	75	75	'3585	563'110
75	'8002	702'7303	6	142'7303	'1998	75	74	'3511	577'469
75	'7927	717'5305	7	097'5305	'2073	75	74	'3437	591'820
76	'7851	732'3232	8	052'3232	'2149	76	75	'3362	606'164
75	'7776	747'1083	9	34007'1083	'2224	75	74	'3288	620'500
75	'7701	761'8859	30	33961'8859	'2299	75	75	'3213	634'829
75	'7626	776'6560	1	916'6560	'2374	75	74	'3139	649'150
76	'7550	791'4186	2	871'4186	'2450	76	75	'3064	663'464
74	'7476	806'1736	3	826'1736	'2524	74	74	'2990	677'707
76	'7400	820'9212	4	780'9212	'2600	76	74	'2916	692'069
75	'7325	835'6612	35	735'6612	'2675	75	75	'2841	706'361
75	'7250	850'3937	6	690'3937	'2750	75	74	'2767	720'645
75	'7175	865'1187	7	645'1187	'2825	75	74	'2693	734'922
75	'7100	879'8362	8	599'8362	'2900	75	75	'2618	749'191
75	'7025	894'5462	9	554'5462	'2975	75	73	'2545	763'453
76	'6949	909'2487	40	509'2487	'3051	76	76	'2469	777'707
74	'6875	923'9436	1	463'9436	'3125	74	73	'2396	791'954
75	'6800	938'6311	2	418'6311	'3200	75	75	'2321	806'194
76	'6724	953'3111	3	373'3111	'3276	76	73	'2248	820'426
74	'6650	967'9835	4	327'9835	'3350	74	75	'2173	834'651
76	'6574	982'6485	45	282'6485	'3426	76	75	'2098	848'868
74	'6500	143997'3059	6	237'3059	'3500	74	73	'2025	863'078
76	'6424	144011'9559	7	191'9559	'3576	76	75	'1950	877'280
74	'6350	026'5983	8	146'5983	'3650	74	74	'1876	891'475
75	'6275	041'2333	9	101'2333	'3725	75	73	'1803	905'663
75	'6200	055'8608	50	055'8608	'3800	75	76	'1727	919'843
75	'6125	070'4808	1	33010'4808	'3875	75	73	'1654	934'016
75	'6050	085'0933	2	32965'0933	'3950	75	74	'1580	948'181
75	'5975	099'6983	3	919'6983	'4025	75	75	'1505	962'339
75	'5900	114'2958	4	874'2958	'4100	75	73	'1432	976'490
75	'5825	128'8858	55	828'8858	'4175	75	75	'1357	144990'633
74	'5751	143'4683	6	783'4683	'4249	74	74	'1283	145004'769
76	'5675	158'0434	7	738'0434	'4325	76	73	'1210	018'897
74	'5601	172'6109	8	692'6109	'4399	74	75	'1135	033'018
75	14'5526	187'1710	9	647'1710	'4474	75	74	'1061	047'132
		144201'7236	60	32601'7236					145061'238

	-31° .	Diff.	Δ° .	Δ° .	Diff.	32° .		-32° .	Diff.	Δ° .
0	32601'7236	"	75	74	"	145061'2381	0	29861'2381	"	74
1	556'2687	45'4549	75	73	14'0987	075'3368	1	815'3368	45'9013	73
2	510'8063	4624	74	75	'0914	089'4282	2	769'4282	'9086	75
3	465'3365	4698	74	74	'0839	103'5121	3	723'5121	'9161	74
4	419'8592	4773	75	73	'0765	117'5886	4	677'5886	'9235	73
5	374'3744	4848	75	75	'0692	131'6578	5	631'6578	'9308	75
6	328'8821	4923	74	74	'0617	145'7195	6	585'7195	'9383	74
7	283'3824	4997	75	73	'0543	159'7738	7	539'7738	'9457	73
8	237'8752	5072	75	75	'0470	173'8208	8	493'8208	'9530	75
9	192'3605	5147	74	73	'0395	187'8603	9	447'8603	'9605	73
		5221			'0322				'9678	
0	146'8384	'5296	75	74	'0248	201'8925	10	401'8925	'9752	74
1	101'3088	'5371	75	74	'0174	215'9173	1	355'9173	'9826	74
2	055'7717	'5445	74	74	'0100	229'9347	2	309'9347	'9900	74
3	32010'2272	'5520	75	73	14'0027	243'9447	3	263'9447	'9973	73
4	31964'6752	'5595	75	75	'0027	257'9474	4	217'9474	45'9973	75
5	919'1157	'5669	74	73	13'9952	271'9426	5	171'9426	46'0048	74
6	873'5488	'5744	75	74	'9879	285'9305	6	125'9305	'0121	73
7	827'9744	'5819	74	74	'9805	299'9110	7	079'9110	'0195	74
8	782'3925	'5893	75	73	'9731	313'8841	8	29033'8841	'0269	73
9	736'8032	'5967	74	75	'9658	327'8499	9	28987'8499	'0342	75
					'9583				'0417	
0	691'2065	'6042	75	73	'9510	341'8082	20	941'8082	'0490	73
1	645'6023	'6117	74	74	'9436	355'7592	1	895'7592	'0564	74
2	599'9906	'6191	74	73	'9363	369'7028	2	849'7028	'0637	74
3	554'3715	'6266	75	74	'9289	383'6391	3	803'6391	'0711	74
4	508'7449	'6340	74	74	'9215	397'5680	4	757'5680	'0785	74
5	463'1109	'6415	75	74	'9141	411'4895	5	711'4895	'0859	74
6	417'4694	'6489	74	73	'9068	425'4036	6	665'4036	'0932	73
7	371'8205	'6563	74	74	'8994	439'3104	7	619'3104	'1006	74
8	326'1642	'6638	75	73	'8921	453'2098	8	573'2098	'1079	73
9	280'5004	'6712	74	74	'8847	467'1019	9	527'1019	'1153	74
0	234'8292	'6787	75	74	'8773	480'9866	30	480'9866	'1227	74
1	189'1505	'6861	74	73	'8700	494'8639	1	434'8639	'1300	73
2	143'4644	'6936	75	74	'8626	508'7339	2	388'7339	'1374	74
3	097'7708	'7010	74	73	'8553	522'5965	3	342'5965	'1447	73
4	052'0698	'7084	74	74	'8479	536'4518	4	296'4518	'1521	74
5	31006'3614	'7159	75	74	'8405	550'2997	5	250'2997	'1595	74
6	30960'6455	'7233	74	73	'8332	564'1402	6	204'1402	'1668	73
7	914'9222	'7307	74	73	'8259	577'9734	7	157'9734	'1741	74
8	869'1915	'7382	75	74	'8185	591'7993	8	111'7993	'1815	73
9	823'4533	'7455	73	74	'8111	605'6178	9	065'6178	'1889	74
0	777'7078	'7531	76	73	'8038	619'4289	40	28019'4289	'1962	73
1	731'9547	'7604	73	73	'7965	633'2327	1	27973'2327	'2035	73
2	686'1943	'7679	75	74	'7891	647'0292	2	927'0292	'2109	74
3	640'4264	'7752	73	73	'7818	660'8183	3	880'8183	'2182	73
4	594'6512	'7827	75	74	'7744	674'6001	4	834'6001	'2256	74
5	548'8685	'7902	75	73	'7671	688'3745	5	788'3745	'2329	73
6	503'0783	'7975	73	73	'7598	702'1416	6	742'1416	'2402	73
7	457'2808	'8050	75	74	'7524	715'9014	7	695'9014	'2476	74
8	411'4758	'8124	74	73	'7451	729'6538	8	649'6538	'2549	73
9	365'6634	'8197	73	74	'7377	743'3989	9	603'3989	'2623	74
0	319'8437	'8273	76	73	'7304	757'1366	50	557'1366	'2696	73
1	274'0164	'8340	73	73	'7231	770'8670	1	510'8670	'2769	73
2	228'1818	'8420	74	73	'7158	784'5901	2	464'5901	'2842	73
3	182'3398	'8495	75	74	'7084	798'3059	3	418'3059	'2916	74
4	136'4903	'8568	73	73	'7011	812'0143	4	372'0143	'2989	73
5	090'6335	'8643	75	73	'6938	825'7154	5	325'7154	'3062	73
6	30044'7692	'8717	74	73	'6865	839'4092	6	279'4092	'3135	74
7	29998'8975	'8790	73	74	'6791	853'0957	7	233'0957	'3209	73
8	953'0185	'8865	75	73	'6718	866'7748	8	186'7748	'3282	73
9	907'1320	'8939	74	73	13'6645	880'4466	9	140'4466	46'3355	73
0	29861'2381					145894'1111	60	27094'1111		

Δ°.	Diff.	33°.	'	-33°.	Diff.	Δ°.	Δ°.	Diff.	34°.
"	"	"	"	"	"	"	"	"	"
73	13'6572	145894'1111	0	27094'1111	46'3428	73	72	13'2206	146700'6374
74	'6498	907'7683	1	047'7683	'3502	74	72	'2134	713'8572
72	'6426	921'4181	2	27001'4181	'3574	72	73	'2061	727'0711
74	'6352	935'0607	3	26955'0607	'3648	74	72	'1989	740'2772
73	'6279	948'6959	4	908'6959	'3721	73	72	'1917	753'4761
73	'6206	962'3238	5	862'3238	'3794	73	73	'1844	766'6678
73	'6133	975'9444	6	815'9444	'3867	73	71	'1773	779'8522
74	'6059	145989'5577	7	769'5577	'3941	74	73	'1700	793'0295
72	'5987	146003'1636	8	723'1636	'4013	72	73	'1627	806'1995
73	'5914	016'7623	9	676'7623	'4086	73	71	'1556	819'3622
74	'5840	030'3537	10	630'3537	'4160	74	73	'1483	832'5178
72	'5768	043'9377	1	583'9377	'4232	72	72	'1411	845'6661
73	'5695	057'5145	2	537'5145	'4305	73	72	'1339	858'8072
74	'5621	071'0840	3	491'0840	'4379	74	72	'1267	871'9411
72	'5549	084'6461	4	444'6461	'4451	72	73	'1194	885'0678
74	'5475	098'2010	15	398'2010	'4525	74	71	'1123	898'1872
72	'5403	111'7485	6	351'7485	'4597	72	73	'1050	911'2995
74	'5329	125'2888	7	305'2888	'4671	74	72	'0978	924'4041
72	'5257	138'8217	8	258'8217	'4743	72	72	'0906	937'5021
73	'5184	152'3474	9	212'3474	'4816	73	72	'0834	950'5920
73	'5111	165'8658	20	165'8658	'4889	73	72	'0762	963'6761
73	'5038	179'3769	1	119'3769	'4962	73	72	'0690	976'7525
73	'4965	192'8807	2	072'8807	'5035	73	72	'0618	146989'8211
73	'4892	206'3772	3	26026'3772	'5108	73	72	'0546	147002'8831
73	'4819	219'8664	4	25979'8664	'5181	73	72	'0474	015'9375
74	'4747	233'3483	25	933'3483	'5253	72	72	'0402	028'9851
72	'4673	246'8230	6	886'8230	'5327	74	72	'0330	042'0251
72	'4601	260'2903	7	840'2903	'5399	72	72	'0258	055'0581
72	'4528	273'7504	8	793'7504	'5472	73	72	'0186	068'0841
72	'4456	287'2032	9	747'2032	'5544	72	72	'0114	081'1021
74	'4382	300'6488	30	700'6488	'5618	74	72	13'0042	094'1141
72	'4310	314'0870	1	654'0870	'5690	72	71	12'9971	107'1181
73	'4237	327'5180	2	607'5180	'5763	73	73	'9898	120'1154
72	'4164	340'9417	3	560'9417	'5836	73	72	'9826	133'1054
72	'4092	354'3581	4	514'3581	'5908	72	71	'9755	146'0880
73	'4019	367'7673	35	467'7673	'5981	73	72	'9683	159'0631
73	'3946	381'1692	6	421'1692	'6054	73	72	'9611	172'0312
73	'3873	394'5638	7	374'5638	'6127	73	72	'9539	184'9920
72	'3801	407'9511	8	327'9511	'6199	72	72	'9467	197'9461
73	'3728	421'3312	9	281'3312	'6272	73	71	'9396	210'8931
72	'3656	434'7040	40	234'7040	'6344	72	72	'9324	223'8331
73	'3583	448'0696	1	188'0696	'6417	73	72	'9252	236'7651
72	'3510	461'4279	2	141'4279	'6490	72	72	'9180	249'6901
72	'3438	474'7789	3	094'7789	'6562	72	72	'9108	262'6081
73	'3365	488'1227	4	048'1227	'6635	73	71	'9037	275'5191
72	'3293	501'4592	45	25001'4592	'6707	72	72	'8965	288'4231
73	'3220	514'7885	6	24954'7885	'6780	73	71	'8894	301'3191
72	'3148	528'1105	7	908'1105	'6852	72	72	'8822	314'2091
73	'3075	541'4253	8	861'4253	'6925	73	72	'8750	327'0911
73	'3002	554'7328	9	814'7328	'6998	73	72	'8678	339'9661
72	'2930	568'0330	50	768'0330	'7070	72	71	'8607	352'8341
72	'2858	581'3260	1	721'3260	'7142	72	72	'8535	365'6941
73	'2785	594'6118	2	674'6118	'7215	73	71	'8464	378'5481
72	'2713	607'8903	3	627'8903	'7287	72	72	'8392	391'3941
73	'2640	621'1616	4	581'1616	'7360	73	72	'8320	404'2331
72	'2568	634'4256	55	534'4256	'7432	72	71	'8249	417'0651
73	'2495	647'6824	6	487'6824	'7505	73	72	'8177	429'8901
72	'2423	660'9319	7	440'9319	'7577	72	72	'8105	442'7081
72	'2351	674'1742	8	394'1742	'7649	72	70	'8035	455'5191
73	13'2278	687'4093	9	347'4093	'7722	73	72	12'7963	468'3221
		146700'6371	60	24300'6371					142481'1181

	-34°.	Diff.	Δ°.	Δ°.	Diff.	35°.		-35°.	Diff.	Δ°.
	"	"			"	"		"	"	
00	24300.6371		72	71	12.7892	147481.1188	0	21481.1188		71
01	253.8577	46.7794	72	72	7820	493.9080	1	433.9080	47.2108	72
02	207.0711	.7866	73	72	7748	506.6900	2	386.6900	.2180	72
03	160.2772	.7939	72	71	7748	519.4648	3	339.4648	.2252	72
04	113.4761	.8011	72	71	7677	532.2325	4	292.2325	.2323	71
05	066.6678	.8083	73	72	7606	544.9931	5	244.9931	.2394	72
06	24019.8522	.8156	71	71	7534	557.7465.	6	197.7465.	.2466	71
07	23973.0295.	.8227	73	72	7463	570.4928	7	150.4928	.2537	72
08	926.1995.	.8300	73	71	7391	583.2319	8	103.2319	.2609	71
09	879.3622	.8373	71	71	7320	595.9639	9	055.9639	.2680	71
		.8444			.7249				.2751	
10	832.5178	.8517	73	72	.7177	608.6888	10	21008.6888	.2823	72
11	785.6661	.8589	72	71	.7106	621.4065.	1	20961.4065.	.2894	71
12	738.8072	.8661	72	72	.7034	634.1171	2	914.1171	.2966	72
13	691.9411	.8733	72	70	.6964	646.8205	3	866.8205	.3036	70
14	645.0678	.8806	73	72	.6892	659.5169	4	819.5169	.3108	72
15	598.1872	.8877	71	72	.6820	672.2061	15	772.2061	.3180	72
16	551.2995.	.8950	73	70	.6750	684.8881	6	724.8881	.3250	70
17	504.4045	.9022	72	72	.6678	697.5631	7	677.5631	.3322	72
18	457.5023	.9094	72	71	.6607	710.2309	8	630.2309	.3393	71
19	410.5929	.9166	72	71	.6536	722.8916	9	582.8916	.3464	71
20	363.6763	.9238	72	71	.6465	735.5452	20	535.5452	.3535	71
21	316.7525	.9310	72	71	.6394	748.1917	1	488.1917	.3606	71
22	269.8215	.9382	72	72	.6322	760.8311	2	440.8311	.3678	72
23	222.8833	.9454	72	71	.6251	773.4633	3	393.4633	.3749	71
24	175.9379	.9526	72	71	.6180	786.0884	4	346.0884	.3820	71
25	128.9853	.9598	72	71	.6109	798.7064	25	298.7064	.3891	71
26	082.0255	.9670	72	71	.6038	811.3173	6	251.3173	.3962	71
27	23035.0585.	.9742	72	71	.5967	823.9211	7	203.9211	.4033	71
28	22988.0843	.9814	72	72	.5895	836.5178	8	156.5178	.4105	72
29	941.1029	.9886	72	70	.5825	849.1073	9	109.1073	.4175	70
30	894.1143	46.9958	72	71	.5754	861.6898	30	061.6898	.4246	71
31	847.1185	47.0029	71	72	.5682	874.2652	1	20014.2652	.4318	72
32	800.1156	.0102	73	70	.5612	886.8334	2	19966.8334	.4388	70
33	753.1054	.0174	72	72	.5540	899.3946	3	919.3946	.4460	72
34	706.0880	.0245	71	70	.5470	911.9486	4	871.9486	.4530	70
35	659.0635	.0317	72	71	.5400	924.4956	35	824.4956	.4601	71
36	612.0318	.0389	72	72	.5329	937.0355.	6	777.0355.	.4673	72
37	564.9929	.0461	72	70	.5257	949.5682	7	729.5682	.4743	70
38	517.9468	.0533	72	71	.5186	962.0939	8	682.0939	.4814	71
39	470.8935	.0604	71	72	.5114	974.6125	9	634.6125	.4886	72
40	423.8331	.0676	72	70	.5044	987.1239	40	587.1239	.4956	70
41	376.7655.	.0748	72	70	.4974	147999.6283	1	539.6283	.5026	70
42	329.6907	.0820	72	72	.4902	148012.1257	2	492.1257	.5098	72
43	282.6087	.0892	72	70	.4832	024.6159	3	444.6159	.5168	70
44	235.5195	.0963	71	72	.4760	037.0991	4	397.0991	.5240	72
45	188.4232	.1035	72	71	.4689	049.5751	45	349.5751	.5311	71
46	141.3197	.1106	71	70	.4619	062.0440	6	302.0440	.5381	70
47	094.2091	.1178	72	71	.4548	074.5059	7	254.5059	.5452	71
48	22047.0913	.1250	72	71	.4478	086.9607	8	206.9607	.5522	70
49	21999.9663	.1322	72	72	.4406	099.4085.	9	159.4085.	.5594	72
50	952.8341	.1393	71	70	.4336	111.8491	50	111.8491	.5664	70
51	905.6948	.1465	72	71	.4265	124.2827	1	064.2827	.5735	71
52	858.5483	.1536	71	71	.4194	136.7092	2	19016.7092	.5806	71
53	811.3947	.1608	72	70	.4124	149.1286	3	18969.1286	.5876	70
54	764.2339	.1680	72	71	.4053	161.5410	4	921.5410	.5947	71
55	717.0659	.1751	71	71	.3982	173.9463	55	873.9463	.6018	71
56	669.8908	.1823	72	70	.3912	186.3445	6	826.3445	.6088	70
57	622.7085	.1895	72	71	.3841	198.7357	7	778.7357	.6159	71
58	575.5190	.1965	70	71	.3770	211.1198	8	731.1198	.6230	71
59	528.3225	47.2037	72	70	12.3700	223.4968	9	683.4968	.6300	70
60	21181.1188				148235.8668		60	18635.8668		

Δ° .	Diff.	36° .		-36° .	Diff.	Δ° .	Δ° .	Diff.	36° .
71	"	148235	0	18635	"	71	71	"	148965
71	12'3629	248'2297	1	588'2297	47'6371	71	69	11'9420	977'1414
70	'3558	260'5855	2	540'5855	'6442	70	69	'9351	148989'0765
70	'3488	272'9343	3	492'9343	'6512	70	71	'9282	149001'0047
71	'3418	285'2761	4	445'2761	'6582	71	69	'9211	012'9258
71	'3347	297'6108	5	397'6108	'6653	71	69	'9142	024'8405
70	'3276	309'9384	6	349'9384	'6724	70	69	'9073	036'7473
71	'3206	322'2590	7	302'2590	'6794	71	70	'9003	048'6470
70	'3135	334'5725	8	254'5725	'6865	70	70	'8933	060'5409
70	'3065	346'8790	9	206'8790	'6935	70	69	'8863	072'4272
	'2995				'7005			'8794	
71		359'1785	10	159'1785		71	69		084'3066
71	'2924	371'4709	1	111'4709	'7076	71	70	'8725	096'1791
70	'2853	383'7562	2	063'7562	'7147	70	70	'8655	108'0446
70	'2783	396'0345	3	18016'0345	'7217	70	69	'8585	119'9031
71	'2713	408'3058	4	17968'3058	'7287	71	69	'8516	131'7542
70	'2642	420'5700	15	920'5700	'7358	70	70	'8447	143'5994
70	'2572	432'8272	6	872'8272	'7428	70	69	'8377	155'4371
71	'2502	445'0774	7	825'0774	'7498	71	70	'8308	167'2679
70	'2431	457'3205	8	777'3205	'7569	70	69	'8238	179'0912
70	'2361	469'5566	9	729'5566	'7639	71	70	'8169	190'9086
	'2290				'7710			'8099	
69		481'7856	20	681'7856		69	69		202'7185
71	'2221	494'0077	1	634'0077	'7779	71	69	'8030	214'5215
71	'2150	506'2227	2	586'2227	'7850	71	70	'7961	226'3176
69	'2079	518'4306	3	538'4306	'7921	69	69	'7891	238'1067
71	'2010	530'6316	4	490'6316	'7990	71	70	'7822	249'8889
70	'1939	542'8255	25	442'8255	'8061	70	68	'7752	261'6641
70	'1869	555'0124	6	395'0124	'8131	70	70	'7684	273'4325
71	'1799	567'1923	7	347'1923	'8201	71	70	'7614	285'1939
69	'1728	579'3651	8	299'3651	'8272	69	68	'7544	296'9483
71	'1659	591'5310	9	251'5310	'8341	71	70	'7476	308'6959
	'1588				'8412			'7406	
70		603'6898	30	203'6898		70	69		320'4365
70	'1518	615'8416	1	155'8416	'8482	70	69	'7337	332'1702
70	'1448	627'9864	2	107'9864	'8552	70	69	'7268	343'8970
70	'1378	640'1242	3	060'1242	'8622	70	68	'7198	355'6168
71	'1308	652'2550	4	17012'2550	'8692	71	70	'7130	367'3298
69	'1237	664'3787	35	16964'3787	'8763	69	69	'7060	379'0358
71	'1168	676'4955	6	916'4955	'8832	71	69	'6991	390'7349
69	'1097	688'6052	7	868'6052	'8903	69	69	'6922	402'4271
69	'1028	700'7080	8	820'7080	'8972	71	70	'6853	414'1124
69	'0957	712'8037	9	772'8037	'9043	69	68	'6783	425'7907
	'0888				'9112			'6715	
71		724'8925	40	724'8925		71	70		437'4622
69	'0817	736'9742	1	676'9742	'9183	69	68	'6645	449'1267
71	'0748	749'0490	2	629'0490	'9252	71	70	'6577	460'7844
69	'0677	761'1167	3	581'1167	'9323	69	69	'6507	472'4351
71	'0608	773'1775	4	533'1775	'9392	71	68	'6438	484'0785
69	'0537	785'2312	45	485'2312	'9463	69	70	'6370	495'7159
70	'0468	797'2780	6	437'2780	'9532	70	69	'6300	507'3459
71	'0398	809'3178	7	389'3178	'9602	71	68	'6231	518'9690
69	'0327	821'3505	8	341'3505	'9673	69	70	'6163	530'5853
70	'0258	833'3763	9	293'3763	'9742	70	69	'6093	542'1946
	'0188				'9812			'6024	
69		845'3951	50	245'3951		69	68		553'7970
71	'0119	857'4070	1	197'4070	'9881	71	69	'5956	565'3926
69	12'0048	869'4118	2	149'4118	47'9952	69	69	'5887	576'9813
70	11'9979	881'4097	3	101'4097	48'0021	70	70	'5818	588'5631
70	'9909	893'4006	4	053'4006	'0091	70	68	'5748	600'1379
70	'9839	905'3845	55	16005'3845	'0161	70	68	'5680	611'7059
69	'9769	917'3614	6	15957'3614	'0231	69	70	'5612	623'2671
71	'9700	929'3314	7	909'3314	'0300	71	69	'5542	634'8213
69	'9629	941'2943	8	861'2943	'0371	69	68	'5473	646'3686
69	'9560	953'2503	9	813'2503	'0440	69	69	'5405	657'9091
	11'9491	148965	60	15765	48'0509			11'5336	149669

-37° .	Diff.	Δ° .	Δ° .	Diff.	38° .		-38° .	Diff.	Δ° .
15765 " 1994	"	71	69	"	149669 " 4427	0	12869 " 4427	"	69
717 " 1414	48 '0580	69	68	11 '5267	680 '9694	1	820 '9694	48 '4733	68
669 '0765	'0649	69	70	'5199	692 '4893	2	772 '4893	'4801	70
621 '0047	'0718	71	68	'5129	704 '0022	3	724 '0022	'4871	68
572 '9258	'0789	69	68	'5061	715 '5083	4	675 '5083	'4939	68
524 '8400	'0858	69	70	'4993	727 '0076	5	627 '0076	'5007	70
476 '7473	'0927	70	68	'4923	738 '4999	6	578 '4999	'5077	68
428 '6476	'0997	70	69	'4855	749 '9854	7	529 '9854	'5145	69
380 '5409	'1067	70	68	'4786	761 '4640	8	481 '4640	'5214	68
332 '4272	'1137	69	69	'4718	772 '9358	9	432 '9358	'5282	69
	'1206			'4649				'5351	
284 '3066	'1275	69	69	'4580	784 '4007	10	384 '4007	'5420	69
236 '1791	'1345	70	68	'4512	795 '8587	1	335 '8587	'5488	68
188 '0446	'1415	70	69	'4443	807 '3099	2	287 '3099	'5557	69
139 '9031	'1484	69	68	'4375	818 '7542	3	238 '7542	'5625	68
91 '7547	'1553	69	69	'4306	830 '1917	4	190 '1917	'5694	69
15043 '5994	'1623	70	68	'4238	841 '6223	15	141 '6223	'5762	68
14995 '4371	'1692	69	69	'4169	853 '0461	6	93 '0461	'5831	69
947 '2079	'1762	70	69	'4100	864 '4630	7	12044 '4630	'5900	68
899 '0917	'1831	69	68	'4032	875 '8730	8	11995 '8730	'5968	69
850 '9086	'1901	70	68	'3964	887 '2762	9	947 '2762	'6036	68
802 '7185	'1970	69	69	'3895	898 '6726	20	898 '6726	'6105	69
754 '5215	'2039	69	68	'3827	910 '0621	1	850 '0621	'6173	68
706 '3176	'2109	70	69	'3758	921 '4448	2	801 '4448	'6242	69
658 '1067	'2178	69	68	'3690	932 '8206	3	752 '8206	'6310	68
609 '8889	'2248	70	69	'3621	944 '1896	4	704 '1896	'6379	69
561 '6641	'2316	68	68	'3553	955 '5517	25	655 '5517	'6447	68
513 '4325	'2386	70	69	'3485	966 '9070	6	606 '9070	'6515	69
465 '1939	'2456	68	68	'3416	978 '2555	7	558 '2555	'6584	68
416 '9483	'2524	70	68	'3348	149989 '5971	8	509 '5971	'6652	69
368 '6959	'2594			'3280	150000 '9319	9	460 '9319	'6720	68
320 '4365	'2663	69	68	'3212	012 '2599	30	412 '2599	'6788	69
272 '1702	'2732	70	69	'3143	023 '5811	1	363 '5811	'6857	68
223 '8970	'2802	69	68	'3075	034 '8954	2	314 '8954	'6925	69
175 '6168	'2870	68	69	'3006	046 '2029	3	266 '2029	'6994	68
127 '3298	'2940	70	67	'2939	057 '5035	4	217 '5035	'7061	69
979 '0358	'3009	69	69	'2870	068 '7974	35	168 '7974	'7130	68
14030 '7349	'3078	69	68	'2802	080 '0844	6	120 '0844	'7198	69
13982 '4271	'3147	70	69	'2734	091 '3646	7	071 '3646	'7266	68
934 '1124	'3217	68	67	'2665	102 '6380	8	11022 '6380	'7335	69
885 '7907	'3285			'2598	113 '9045	9	10973 '9045	'7402	67
837 '4622	'3355	70	68	'2530	125 '1643	40	925 '1643	'7470	68
789 '1267	'3423	69	69	'2461	136 '4173	1	876 '4173	'7539	69
740 '7844	'3493	70	68	'2393	147 '6634	2	827 '6634	'7607	68
692 '4351	'3562	69	68	'2325	158 '9027	3	778 '9027	'7675	69
644 '0789	'3630	68	68	'2257	170 '1352	4	730 '1352	'7743	68
595 '7159	'3700	70	68	'2189	181 '3609	45	681 '3609	'7811	69
547 '3459	'3769	69	68	'2121	192 '5798	6	632 '5798	'7879	68
498 '9690	'3837	68	68	'2053	203 '7919	7	583 '7919	'7947	69
450 '5853	'3907	70	68	'1985	214 '9972	8	534 '9972	'8015	68
402 '1946	'3976	69	69	'1916	226 '1957	9	486 '1957	'8084	69
353 '7970	'4044	68	67	'1849	237 '3873	50	437 '3873	'8151	67
305 '3926	'4113	69	68	'1781	248 '5722	1	388 '5722	'8219	68
256 '9813	'4182	69	68	'1713	259 '7503	2	339 '7503	'8287	69
208 '5631	'4252	70	68	'1645	270 '9216	3	290 '9216	'8355	68
160 '1379	'4320	68	68	'1577	282 '0861	4	242 '0861	'8423	69
111 '7059	'4388	69	67	'1510	293 '2438	55	193 '2438	'8490	68
63 '2671	'4458	70	69	'1441	304 '3948	6	144 '3948	'8559	69
13014 '8213	'4527	69	68	'1373	315 '5389	7	95 '5389	'8627	68
12966 '3686	'4595	68	67	'1306	326 '6762	8	10046 '6762	'8694	69
917 '9091	48 '4664	69	68	11 '1238	337 '8068	9	9997 '8068	48 '8762	68
12869 '4427					150348 '9306	60	9948 '9306		

Δ^1 .	Diff.	39° .	'	-39° .	Diff.	Δ^2 .	Δ^2 .	Diff.	40° .
68	"	"	0	"	"	68	67	"	"
68	II'1170	150348'9306	0	9948'9306	48'8830	68	67	IO'7130	151004'0043
68	'1102	360'0476	1	900'0476	'8898	68	66	'7064	014'7173
68	'1034	371'1578	2	851'1578	'8966	68	66	'6996	025'4237
67	'0967	382'2612	3	802'2612	'9033	67	66	'6930	036'1233
68	'0899	393'3579	4	753'3579	'9101	68	66	'6864	046'8163
68	'0831	404'4478	5	704'4478	'9169	68	68	'6796	057'5027
68	'0763	415'5309	6	655'5309	'9237	68	67	'6729	068'1823
67	'0696	426'6072	7	606'6072	'9304	67	66	'6663	078'8552
68	'0628	437'6768	8	557'6768	'9372	68	67	'6596	089'5215
68	'0560	448'7396	9	508'7396	'9440	68	67	'6529	100'1811
67	'0493	459'7956	10	459'7956	'9507	67	66	'6463	110'8340
68	'0425	470'8449	1	410'8449	'9575	68	67	'6396	121'4803
68	'0357	481'8874	2	361'8874	'9643	68	66	'6330	132'1199
67	'0290	492'9231	3	312'9231	'9710	67	67	'6263	142'7529
68	'0222	503'9521	4	263'9521	'9778	68	67	'6196	153'3792
67	'0155	514'9743	15	214'9743	'9845	67	67	'6129	163'9988
68	'0087	525'9898	6	165'9898	'9913	68	66	'6063	174'6117
67	II'0020	536'9985	7	116'9985	48'9980	67	67	'5996	185'5218
68	IO'9952	548'0005	8	068'0005	49'0048	68	66	'5930	195'8176
68	'9884	558'9957	9	9018'9957	'0116	68	67	'5863	206'4106
67	'9817	569'9841	20	8969'9841	'0183	67	66	'5797	216'9966
67	'9750	580'9658	1	920'9658	'0250	67	67	'5730	227'5766
68	'9682	591'9408	2	871'9408	'0318	68	66	'5664	238'1496
68	'9614	602'9090	3	822'9090	'0386	68	67	'5597	248'7166
67	'9547	613'8704	4	773'8704	'0453	67	66	'5531	259'2757
67	'9480	624'8251	25	724'8251	'0520	67	67	'5464	269'8288
68	'9412	635'7731	6	675'7731	'0588	68	66	'5398	280'3752
67	'9345	646'7143	7	626'7143	'0655	67	66	'5332	290'9150
67	'9278	657'6488	8	577'6488	'0722	67	67	'5265	301'4482
68	'9210	668'5766	9	528'5766	'0790	68	66	'5199	311'9742
67	'9143	679'4976	30	479'4976	'0857	67	67	'5132	322'4946
68	'9075	690'4119	1	430'4119	'0925	68	66	'5066	333'0078
66	'9009	701'3194	2	381'3194	'0991	66	66	'5000	343'5144
68	'8941	712'2203	3	332'2203	'1059	68	66	'4934	354'0144
68	'8873	723'1144	4	283'1144	'1127	68	67	'4867	364'5078
66	'8807	734'0017	35	234'0017	'1193	66	66	'4801	374'9948
68	'8739	744'8824	6	184'8824	'1261	68	67	'4734	385'4746
67	'8672	755'7563	7	135'7563	'1328	67	66	'4668	395'9480
68	'8604	766'6235	8	086'6235	'1396	68	65	'4603	406'4148
66	'8538	777'4839	9	8037'4839	'1462	66	67	'4536	416'8751
68	'8470	788'3377	40	7988'3377	'1530	68	67	'4469	427'3287
67	'8403	799'1847	1	939'1847	'1597	67	65	'4404	437'7756
66	'8337	810'0250	2	890'0250	'1663	66	67	'4337	448'2160
68	'8269	820'8587	3	840'8587	'1731	68	66	'4271	458'6497
68	'8201	831'6856	4	791'6856	'1799	68	65	'4206	469'0768
66	'8135	842'5057	45	742'5057	'1865	66	67	'4139	479'4974
67	'8068	853'3192	6	693'3192	'1932	67	67	'4072	489'9113
67	'8001	864'1260	7	644'1260	'1999	67	65	'4007	500'3182
68	'7933	874'9261	8	594'9261	'2067	68	66	'3941	510'7192
67	'7866	885'7194	9	545'7194	'2134	67	66	'3875	521'1133
66	'7800	896'5060	50	496'5060	'2200	66	66	'3809	531'5008
67	'7733	907'2860	1	447'2860	'2267	67	67	'3742	541'8812
68	'7665	918'0593	2	398'0593	'2335	68	65	'3677	552'2559
66	'7599	928'8258	3	348'8258	'2401	66	66	'3611	562'6236
67	'7532	939'5857	4	299'5857	'2468	67	67	'3544	572'9842
68	'7464	950'3389	55	250'3389	'2536	68	65	'3479	583'3391
66	'7398	961'0853	6	201'0853	'2602	66	66	'3413	593'6870
67	'7331	971'8251	7	151'8251	'2669	67	66	'3347	604'0283
67	'7264	982'5582	8	102'5582	'2736	67	65	'3282	614'3630
67	IO'7197	150993'2846	9	053'2846	49'2803	67	67	IO'3215	624'6912
		151004'0043	60	7004'0043					151635'0127

-40° .	Diff.	Δ° .	Δ° .	Diff.	41° .	$'$	-41° .	Diff.	Δ° .
"	"	"	"	"	"	"	"	"	"
7004.0043		67	66	10.3149	151635.0127	0	4035.0127	49.6851	66
6954.7173	49.2870	66	66	3083	645.3276	1	3985.3276	6917	65
905.4237	2936	68	65	3018	655.6359	2	935.6359	6982	65
856.1233	3004	66	66	2952	665.9377	3	885.9377	7048	66
806.8163	3070	66	66	2886	676.2329	4	836.2329	7114	66
757.5027	3136	68	66	2820	686.5215	5	786.5215	7180	65
708.1823	3204	67	65	2755	696.8035	6	736.8035	7245	66
658.8552	3271	66	66	2689	707.0790	7	687.0790	7311	66
609.5215	3337	67	66	2623	717.3479	8	637.3479	7377	66
560.1811	3404	67	66	2557	727.6102	9	587.6102	7443	65
	3471								
510.8340	3537	66	65	2492	737.8659	10	537.8659	7508	66
461.4803	3604	67	66	2426	748.1151	1	488.1151	7574	66
412.1199	3670	66	66	2360	758.3577	2	438.3577	7640	66
362.7529	3737	67	65	2295	768.5937	3	388.5937	7705	65
313.3792	3804	67	66	2229	778.8232	4	338.8232	7771	66
263.9988	3871	67	66	2163	789.0461	15	289.0461	7837	65
214.6117	3937	66	65	2098	799.2624	6	239.2624	7902	65
165.2180	4004	67	65	2033	809.4722	7	189.4722	7967	65
115.8176	4070	66	66	1967	819.6755	8	139.6755	8033	66
66.4106	4137	67	66	1901	829.8722	9	89.8722	8099	66
6016.9969	4203	66	66	1835	840.0623	20	3040.0623	8165	66
5967.5766	4270	67	65	1770	850.2458	1	2990.2458	8230	65
918.1496	4336	66	65	1705	860.4228	2	940.4228	8295	65
868.7160	4403	67	66	1639	870.5933	3	890.5933	8361	65
819.2757	4469	66	65	1574	880.7572	4	840.7572	8426	65
769.8288	4536	67	66	1508	890.9146	25	790.9146	8492	66
720.3752	4602	66	65	1443	901.0654	6	741.0654	8557	65
670.9150	4668	66	66	1377	911.2097	7	691.2097	8623	66
621.4482	4735	67	65	1312	921.3474	8	641.3474	8688	65
571.9747	4801	66	65	1247	931.4786	9	591.4786	8753	65
522.4946	4868	67	65	1182	941.6033	30	541.6033	8818	65
473.0078	4934	66	66	1116	951.7215	1	491.7215	8884	66
423.5144	5000	66	66	1050	961.8331	2	441.8331	8950	66
374.0144	5066	66	65	985	971.9381	3	391.9381	9015	65
324.5078	5133	67	65	920	982.0366	4	342.0366	9080	65
274.9945	5199	66	65	855	151992.1286	35	292.1286	9145	65
225.4746	5266	67	65	790	152002.2141	6	242.2141	9210	66
175.9480	5332	66	66	724	012.2931	7	192.2931	9276	66
126.4148	5397	65	65	659	022.3655	8	142.3655	9341	65
97.8751	5464	67	65	594	032.4314	9	92.4314	9406	65
5027.3287	5531	67	65	529	042.4908	40	2042.4908	9471	65
4977.7756	5596	65	66	463	052.5437	1	1992.5437	9537	66
928.2160	5663	67	65	398	062.5900	2	942.5900	9602	65
878.6497	5729	66	65	333	072.6298	3	892.6298	9667	65
829.0768	5794	65	65	268	082.6631	4	842.6631	9732	65
779.4974	5861	67	65	203	092.6899	45	792.6899	9797	65
729.9113	5928	67	65	138	102.7102	6	742.7102	9862	65
680.3185	5993	65	65	73	112.7240	7	692.7240	9927	65
630.7192	6059	66	65	7	122.7313	8	642.7313	9992	65
581.1133	6125	66	65	10.0008	132.7321	9	592.7321	10057	65
				9.9943					
531.5008	6191	66	66	9877	142.7264	50	542.7264	0123	66
481.8817	6258	67	64	9813	152.7141	1	492.7141	0187	64
432.2559	6323	65	65	9748	162.6954	2	442.6954	0252	65
382.6236	6389	66	66	9682	172.6702	3	392.6702	0318	66
332.9847	6456	67	64	9618	182.6384	4	342.6384	0382	64
283.3391	6521	65	65	9553	192.6002	55	292.6002	0447	65
233.6870	6587	66	65	9488	202.5555	6	242.5555	0512	65
184.0283	6653	66	65	9423	212.5043	7	192.5043	0577	65
134.3630	6718	65	65	9358	222.4466	8	142.4466	0642	65
84.6912	6785	67	65	9293	232.3824	9	92.3824	0707	65
4035.0127	49.6785				152242.3117	60	1042.3117		

Δ^2	Diff.	42°		-42°	Diff.	Δ^2	Δ^2	Diff.	43°		
64	"	"	"	"	"	"	"	"	"		
66	9'9229	152242	3117	0	1042	3117	64	65	152826	264	
64	9163	252	2346	1	992	2346	66	63	9'5368	835	801
64	9099	262	1509	2	942	1509	64	64	5305	845	332
65	9034	272	0608	3	892	0608	64	64	5241	854	856
65	8969	281	0642	4	841	0642	65	65	5177	864	373
65	8904	291	8611	5	791	8611	65	64	5114	873	885
64	8840	301	7515	6	741	7515	65	64	5050	883	390
65	8775	311	6355	7	691	6355	65	64	4986	892	888
65	8710	321	5130	8	641	5130	65	63	4922	902	381
64	8646	331	3840	9	591	3840	64	64	4859	911	867
66	8580	341	2486	10	541	2486	66	64	4795	921	346
63	8517	351	1066	1	491	1066	63	63	4731	930	819
66	8451	360	9583	2	440	9583	66	64	4668	940	286
64	8387	370	8034	3	390	8034	64	64	4604	949	746
65	8322	380	6421	4	340	6421	65	63	4540	959	2008
64	8258	390	4743	15	290	4743	64	64	4477	968	648
65	8193	400	3001	6	240	3001	65	63	4413	978	089
65	8128	410	1194	7	190	1194	65	64	4350	987	524
64	8064	419	9322	8	139	9322	64	63	4286	152996	9534
64	8000	429	7386	9	89	7386	64	64	4223	153006	3757
65	7935	439	5386	20	39	5386	65	63	4159	015	7916
65	7870	449	3321	1	10	6679	65	64	4096	025	2012
64	7806	459	1191	2	60	8809	64	63	4032	034	6044
65	7742	468	8997	3	111	1003	65	64	3969	044	0013
64	7677	478	6739	4	161	3261	64	63	3906	053	3919
65	7613	488	4416	25	211	5584	65	64	3842	062	7761
65	7548	498	2029	6	261	7971	65	62	3778	072	1539
64	7484	507	9577	7	312	0423	64	64	3716	081	5255
65	7419	517	7061	8	362	2939	65	64	3652	090	8907
64	7355	527	4480	9	412	5520	64	63	3588	100	2495
64	7291	537	1835	30	462	8165	64	63	3525	109	6020
65	7226	546	9126	1	513	0874	65	63	3462	118	9482
64	7162	556	6352	2	563	3648	64	64	3399	128	2881
64	7098	566	3514	3	613	6486	64	62	3335	137	6216
65	7034	576	0612	4	663	9388	65	64	3273	146	9489
64	6969	585	7646	35	714	2354	64	63	3209	156	2698
64	6905	595	4615	6	764	5385	64	64	3146	165	
64	6841	605	1520	7	814	8180	64	63	3082	174	8926
64	6777	614	8361	8	865	1639	64	62	3019	184	1945
65	6712	624	5138	9	915	4862	65	64	2957	193	4902
63	6649	634	1850	40	965	8150	63	64	2893	202	7795
65	6584	643	8499	1	1016	1501	65	62	2829	212	0624
64	6520	653	5083	2	066	4917	64	63	2767	221	3391
64	6456	663	1603	3	116	8397	64	63	2704	230	6095
64	6392	672	8059	4	167	1941	64	64	2641	239	8736
65	6327	682	4451	45	217	5549	65	62	2577	249	1313
63	6264	692	0778	6	267	9222	63	64	2515	258	3828
64	6200	701	7042	7	318	2958	64	62	2451	267	6279
65	6135	711	3242	8	368	6758	65	64	2389	276	8668
63	6072	720	9377	9	419	0623	63	62	2325	286	0993
65	6007	730	5449	50	469	4551	65	63	2263	295	3256
63	5944	740	1456	1	519	8544	63	63	2200	304	5456
64	5880	749	7400	2	570	2600	64	63	2137	313	7593
65	5815	759	3280	3	620	6720	65	64	2074	322	9667
63	5752	768	9095	4	671	0905	63	62	2010	332	1677
64	5688	778	4847	55	721	5153	64	63	1948	341	3625
64	5624	788	0535	6	771	9465	64	62	1885	350	5510
64	5560	797	6159	7	822	3841	64	64	1823	359	7323
64	5496	807	1719	8	872	8281	64	62	1759	368	9092
63	9'5433	816	7215	9	923	2785	63	63	1697	378	0789
		152826	2648	60	1973	7352			9'1634	387	2423

-43°	Diff.	Δ°	Δ°	Diff.	44°	'	-44°	Diff.	Δ°
"	"	"	"	"	"	"	"	"	"
1973 7352	50 4632	65	63	9 1571	153387 2423	0	5012 7577	50 8429	63
2024 1984	4695	63	63	1508	396 3994	1	063 6006	8492	63
074 6679	4759	64	62	1446	405 5502	2	114 4498	8554	62
125 1438	4823	64	63	1383	414 6948	3	165 3052	8617	63
175 6261	4886	64	63	1320	423 8331	4	216 1669	8680	63
226 1147	4950	64	63	1257	432 9651	5	267 0349	8743	63
276 6097	5014	64	62	1195	442 0908	6	317 9092	8805	62
327 1111	5078	64	63	1132	451 2103	7	368 7897	8868	63
377 6189	5141	63	62	1070	460 3235	8	419 6765	8930	62
428 1330	5205	64	63	1007	469 4305	9	470 5695	8993	63
478 6535	5269	64	63	0944	478 5312	10	521 4688	9056	63
529 1804	5332	63	62	0882	487 6236	1	572 3744	9118	62
579 7136	5396	64	63	0819	496 7138	2	623 2862	9181	63
630 2532	5460	64	62	0757	505 7957	3	674 2043	9243	62
680 7992	5523	63	63	0694	514 8714	4	725 1286	9306	63
731 3515	5587	64	63	0631	523 9408	15	776 0592	9369	63
781 9102	5650	63	62	0569	533 0039	6	826 9961	9431	62
832 4752	5714	64	62	0507	542 0608	7	877 9392	9493	62
883 0466	5777	63	63	0444	551 1115	8	928 8885	9556	63
933 6243	5841	64	62	0382	560 1559	9	979 8441	9618	62
2984 2084	5904	63	63	0319	569 1941	20	6030 8059	9681	63
3034 7988	5968	64	62	0257	578 2260	1	081 7740	9743	62
085 3956	6031	63	62	0195	587 2517	2	132 7483	9805	62
135 9987	6094	63	63	0132	596 2712	3	183 7288	9868	63
186 6081	6158	64	62	0070	605 2844	4	234 7156	9930	62
237 2239	6222	62	63	9 0007	614 2914	25	285 7086	50 9993	63
287 8461	6284	62	62	8 9945	623 2921	6	336 7079	51 0055	62
338 4745	6348	64	62	9883	632 2866	7	387 7134	0117	62
389 1093	6412	64	62	9821	641 2749	8	438 7251	0179	62
439 7505	6475	63	63	9758	650 2570	9	489 7430	0242	63
490 3980	6538	63	61	9697	659 2328	30	540 7672	0303	61
541 0518	6601	63	63	9634	668 2025	1	591 7975	0366	63
591 7119	6665	64	63	9571	677 1659	2	642 8341	0429	63
642 3784	6727	64	61	9510	686 1230	3	693 8770	0490	61
693 0511	6791	64	63	9447	695 0740	4	744 9260	0553	63
743 7302	6854	63	62	9385	704 0187	35	795 9813	0615	62
794 4156	6918	64	62	9323	712 9572	6	847 0428	0677	62
845 1074	6981	63	62	9261	721 8895	7	898 1105	0739	62
895 8055	7043	62	62	9199	730 8156	8	949 1844	0801	62
946 5098	7107	64	63	9136	739 7355	9	7000 2645	0864	63
3997 2205	7171	64	61	9075	748 6491	40	051 3509	0925	61
4047 9376	7233	62	62	9013	757 5566	1	102 4434	0987	62
098 6609	7296	63	62	8951	766 4579	2	153 5421	1049	62
149 3905	7359	63	63	8888	775 3530	3	204 6470	1112	63
200 1264	7423	64	61	8827	784 2418	4	255 7582	1173	61
250 8687	7485	62	63	8764	793 1245	45	306 8755	1236	63
301 6172	7549	64	61	8703	802 0009	6	357 9991	1297	61
352 3721	7611	62	63	8640	810 8712	7	409 1288	1360	63
403 1332	7675	64	61	8579	819 7352	8	460 2648	1421	61
453 9007	7737	62	62	8517	828 5931	9	511 4069	1483	62
504 6744	7800	63	62	8455	837 4448	50	562 5552	1545	62
555 4544	7863	63	62	8393	846 2903	1	613 7097	1607	62
606 2407	7926	64	61	8331	855 1296	2	664 8704	1669	62
657 0333	7990	64	63	8270	863 9627	3	716 0373	1730	61
707 8323	8052	62	63	8207	872 7897	4	767 2103	1793	63
758 6375	8115	63	61	8146	881 6104	55	818 3896	1854	61
809 4490	8177	62	62	8084	890 4250	6	869 5750	1916	62
860 2667	8241	64	61	8023	899 2334	7	920 7666	1977	61
911 0908	8303	62	63	7960	908 0357	8	971 9643	2040	63
961 9211	8366	63	61	7899	916 8317	9	8023 1683	2101	61
5012 7577					153925 6216	60	8074 3784		

Δ° .	Diff.	45° .		-45° .	Diff.	Δ° .	Δ° .	Diff.	46° .
"	"	"	"	"	"	"	"	"	"
62	8'7837	153925'6216	0	8074'3784	51'2163	62	60	8'4168	154441'7871
61	'7776	934'4053	1	125'5947	'2224	61	61	'4107	450'2039
63	'7713	943'1829	2	176'8171	'2287	63	61	'4046	458'6146
61	'7652	951'9542	3	228'0458	'2348	61	60	'3986	467'0192
61	'7591	960'7194	4	279'2806	'2409	61	60	'3926	475'4178
62	'7529	969'4785	5	330'5215	'2471	62	61	'3865	483'8104
62	'7467	978'2314	6	381'7686	'2533	62	61	'3804	492'1969
61	'7406	986'9781	7	433'0219	'2594	61	60	'3744	500'5773
62	'7344	153995'7187	8	484'2813	'2656	62	60	'3684	508'9517
62	'7282	154004'4531	9	535'5469	'2718	62	61	'3623	517'3201
61	'7221	013'1813	10	586'8187	'2779	61	61	'3562	525'6824
61	'7160	021'9034	1	638'0966	'2840	61	60	'3502	534'0386
62	'7098	030'6194	2	689'3806	'2902	62	60	'3442	542'3888
61	'7037	039'3292	3	740'6708	'2963	61	61	'3381	550'7330
62	'6975	048'0329	4	791'9671	'3025	62	60	'3321	559'0711
62	'6913	056'7304	15	843'2696	'3087	62	60	'3261	567'4032
61	'6852	065'4217	6	894'5783	'3148	61	61	'3200	575'7293
61	'6791	074'1069	7	945'8931	'3209	61	60	'3140	584'0493
61	'6730	082'7860	8	997'2140	'3270	61	60	'3080	592'3633
62	'6668	091'4590	9	9048'5410	'3332	62	61	'3019	600'6713
61	'6607	100'1258	20	099'8742	'3393	61	59	'2960	608'9732
62	'6545	108'7865	1	151'2135	'3455	62	61	'2899	617'2692
61	'6484	117'4410	2	202'5590	'3516	61	59	'2838	625'5591
61	'6423	126'0894	3	253'9106	'3577	61	61	'2779	633'8429
62	'6362	134'7317	4	305'2683	'3638	61	61	'2718	642'1208
62	'6300	143'3679	25	356'6321	'3700	62	60	'2658	650'3926
61	'6239	151'9979	6	408'0021	'3761	61	60	'2598	658'6584
61	'6178	160'6218	7	459'3782	'3822	61	60	'2538	666'9182
62	'6116	169'2396	8	510'7604	'3884	62	60	'2478	675'1720
60	'6056	177'8512	9	562'1488	'3944	60	60	'2418	683'4198
62	'5994	186'4568	30	613'5432	'4006	62	60	'2358	691'6616
61	'5933	195'0562	1	664'9438	'4067	61	61	'2297	699'8974
61	'5872	203'6495	2	716'3505	'4128	61	60	'2237	708'1271
61	'5811	212'2367	3	767'7633	'4189	61	59	'2178	716'3508
61	'5750	220'8178	4	819'1822	'4250	61	60	'2118	724'5686
61	'5689	229'3928	35	870'6072	'4311	61	61	'2057	732'7804
61	'5628	237'9617	6	922'0383	'4372	61	59	'2007	740'9861
62	'5566	246'5245	7	973'4755	'4434	62	60	'1998	749'1859
60	'5506	255'0811	8	10024'9189	'4494	60	61	'1938	757'3797
62	'5444	263'6317	9	076'3683	'4556	62	59	'1877	765'5674
60	'5384	272'1761	40	127'8239	'4616	60	60	'1818	773'7492
61	'5323	280'7145	1	179'2855	'4677	61	60	'1758	781'9250
62	'5261	289'2468	2	230'7532	'4739	62	60	'1698	790'0948
60	'5201	297'7729	3	282'2271	'4799	60	61	'1639	798'2587
61	'5140	306'2930	4	333'7070	'4860	61	59	'1578	806'4165
61	'5079	314'8070	45	385'1930	'4921	61	60	'1519	814'5684
61	'5018	323'3149	6	436'6851	'4982	61	60	'1459	822'7143
61	'4957	331'8167	7	488'1833	'5043	61	60	'1399	830'8542
60	'4897	340'3124	8	539'6876	'5103	60	60	'1339	838'9881
62	'4835	348'8021	9	591'1979	'5165	62	59	'1279	847'1160
60	'4775	357'2856	50	642'7144	'5225	60	60	'1220	855'2380
61	'4714	365'7631	1	694'2369	'5286	61	59	'1160	863'3540
61	'4653	374'2345	2	745'7655	'5347	61	60	'1101	871'4611
60	'4593	382'6998	3	797'3002	'5407	60	60	'1041	879'5682
61	'4532	391'1591	4	848'8409	'5468	61	60	'0981	887'6663
61	'4471	399'6123	55	900'3877	'5529	61	59	'0921	895'7584
61	'4410	408'0594	6	10951'9406	'5590	61	60	'0862	903'8446
60	'4350	416'5004	7	11003'4996	'5650	60	59	'0802	911'9248
61	'4289	424'9354	8	055'0646	'5711	61	60	'0743	919'9991
61	8'4228	433'3643	9	106'6357	'5772	61	59	'0683	928'0674
		154441'7871	60	11158'2129				8'0624	154936'1298

-46.	Diff.	Δ^2 .	Δ^2 .	Diff.	47°.	'	-47°.	Diff.	Δ^2 .
1158'2129	"	60	60	"	154936'1208	0	14263'8702	"	60
209'7961	51'5832	61	59	8'0564	944'1862	1	315'8138	51'9436	59
261'3854	5893	61	60	'0505	952'2367	2	367'7633	'9495	60
312'9808	5954	60	59	'0445	960'2812	3	419'7188	'9555	59
364'5822	6014	60	60	'0386	968'3198	4	471'6802	'9614	60
416'1896	6074	61	59	'0326	976'3524	5	523'6476	'9674	59
467'8031	6135	61	60	'0267	984'3791	6	575'6209	'9733	60
519'4227	6196	61	59	'0207	154992'3998	7	627'6002	'9793	59
571'0483	6256	60	59	'0148	155000'1146	8	679'5854	'9852	59
622'6799	6316	61	60	'0089	008'4235.	9	731'5765	'9911	60
	6377			8'0029				51'9971	
674'3176	'6438	61	59	7'9970	016'4264	10	783'5736	52'0030	59
725'9614	'6498	60	59	'9911	024'4234	1	835'5766	'0089	59
777'6112	'6558	60	60	'9851	032'4145.	2	887'5855	'0149	60
829'2670	'6619	61	59	'9792	040'3996	3	939'6004	'0208	59
880'9289	'6679	60	59	'9733	048'3788	4	14991'6212	'0267	59
932'5968	'6739	61	60	'9674	056'3521	5	15043'6479	'0326	60
11984'2707	'6800	61	59	'9614	064'3195.	6	095'6805	'0386	59
12035'9507	'6860	60	59	'9555	072'2809	7	147'7191	'0445	59
087'6367	'6920	61	59	'9496	080'2364	8	199'7636	'0504	59
139'3287	'6981	59	59	'9437	088'1860	9	251'8140	'0563	59
191'0268	'7040	59	59	'9378	096'1297	20	303'8703	'0622	59
242'7308	'7101	61	59	'9319	104'0675	1	355'9325	'0681	59
294'4409	'7162	61	60	'9259	111'9994	2	408'0006	'0741	60
346'1571	'7221	59	58	'9201	119'9253	3	460'0747	'0799	58
397'8792	'7282	61	60	'9141	127'8454	4	512'1546	'0859	59
449'6074	'7342	60	59	'9082	135'7595	25	564'2405.	'0918	58
501'3416	'7402	60	58	'9024	143'6677	6	616'3323	'0976	59
553'0818	'7462	60	60	'8964	151'5701	7	668'4299	'1036	60
604'8280	'7522	60	59	'8905	159'4665.	8	720'5335	'1095	59
656'5802	'7582	60	59	'8846	167'3570	9	772'6430	'1154	59
708'3384	'7642	61	59	'8787	175'2416	30	824'7584	'1213	59
760'1026	'7703	60	58	'8729	183'1203	1	876'8797	'1271	58
811'8729	'7763	60	59	'8670	190'9932	2	929'0068	'1330	59
863'6492	'7822	59	60	'8610	198'8602	3	15981'1398	'1390	60
915'4314	'7882	60	58	'8552	206'7212	4	16033'2788	'1448	58
12967'2196	'7943	61	59	'8493	214'5764	35	085'4236	'1507	59
13019'0139	'8002	59	59	'8434	222'1257	6	137'5743	'1566	59
070'8141	'8062	60	59	'8375	230'2691	7	189'7309	'1625	59
122'6203	'8123	61	59	'8316	238'1066	8	241'8934	'1684	59
174'4326	'8182	59	58	'8258	245'9382	9	294'0618	'1742	58
226'2508	'8242	60	60	'8198	253'7640	40	346'2360	'1802	60
278'0750.	'8302	61	58	'8140	261'5838	1	398'4162	'1860	58
329'9052	'8361	59	58	'8082	269'3978	2	450'6022	'1918	58
381'7413	'8422	61	60	'8022	277'2060	3	502'7940	'1978	60
433'5835	'8481	59	58	'7964	285'0082	4	554'9918	'2036	58
485'4316	'8541	60	59	'7905	292'8046	45	607'1954	'2095	59
537'2857	'8601	60	58	'7847	300'5951	6	659'4049	'2153	58
589'1458	'8661	60	59	'7788	308'3798	7	711'6202	'2212	59
641'0119	'8721	61	59	'7729	316'1586	8	763'8414	'2271	59
692'8840	'8780	59	58	'7671	323'9315	9	816'0685.	'2329	58
744'7620	'8840	60	59	'7612	331'6986	50	868'3014	'2388	59
796'6460	'8899	59	58	'7554	339'4598	1	920'5402	'2446	58
848'5359	'8959	60	59	'7495	347'2152	2	16972'7848	'2505	59
900'4318	'9019	60	59	'7436	354'9647	3	17025'0353	'2564	59
13952'3337	'9079	60	58	'7378	362'7083	4	077'2917	'2622	58
14004'2416	'9138	59	58	'7320	370'4461	55	129'5539	'2680	59
056'1554	'9198	60	59	'7261	378'1781	6	181'8219	'2739	58
108'0752	'9257	59	59	'7202	385'9042	7	234'0958	'2798	59
160'0009	'9317	60	58	'7144	393'6244	8	286'3756	'2856	58
211'9326	'9376	59	58	'7086	401'3388	9	338'6612	'2914	58
14263'8702	51'9376			7'7086	155409'0474	60	17390'9526		

Δ°.	Diff.	48°.	'	-48°.	Diff.	Δ°.	Δ°.	Diff.	49°.
58	"	"	"	"	"	58	56	"	"
58	7' 7028	155409' 0474	0	17390' 9526	52' 2972	58	56	7' 3559	155860' 9442
59	'6969	416' 7502	1	443' 2498	'3031	59	58	'3501	868' 3002
59	'6910	424' 4471	2	495' 5529	'3090	59	57	'3444	875' 6502
57	'6853	432' 1381	3	547' 8619	'3147	57	57	'3337	882' 9946
59	'6794	439' 8234	4	600' 1766	'3206	59	57	'3330	890' 3337
59	'6735	447' 5028	5	652' 4972	'3265	59	58	'3272	897' 6667
58	'6677	455' 1763	6	704' 8237	'3323	58	56	'3216	904' 9933
57	'6620	462' 8440	7	757' 1560	'3380	57	58	'3158	912' 3151
59	'6561	470' 5060	8	809' 4940	'3439	59	57	'3101	919' 6309
59	'6502	478' 1621	9	861' 8379	'3498	59	57	'3044	926' 9410
57	'6445	485' 8123	10	914' 1877	'3555	57	57	'2987	934' 2455
59	'6386	493' 4568	1	17966' 5432	'3614	59	57	'2930	941' 5441
58	'6328	501' 0954	2	18018' 9046	'3672	58	57	'2873	948' 8371
58	'6270	508' 7282	3	071' 2718	'3730	58	57	'2816	956' 1241
58	'6212	516' 3552	4	123' 6448	'3788	58	57	'2759	963' 4060
58	'6154	523' 9764	15	176' 0236	'3846	58	57	'2702	970' 6810
59	'6095	531' 5918	6	228' 4082	'3905	59	57	'2645	977' 9521
57	'6038	539' 2013	7	280' 7987	'3962	57	57	'2588	985' 2160
59	'5979	546' 8051	8	333' 1949	'4021	59	56	'2532	992' 4754
57	'5922	554' 4030	9	385' 5970	'4078	57	58	'2474	155999' 7280
59	'5863	561' 9952	20	438' 0048	'4137	59	56	'2418	156006' 9760
57	'5806	569' 5815	1	490' 4185	'4194	57	58	'2360	014' 2170
58	'5748	577' 1621	2	542' 8379	'4252	58	56	'2304	021' 4530
59	'5689	584' 7369	3	595' 2631	'4311	59	57	'2247	028' 6842
57	'5632	592' 3058	4	647' 6942	'4368	57	57	'2190	035' 9080
59	'5573	599' 8690	25	700' 1310	'4427	59	56	'2134	043' 1270
57	'5516	607' 4263	6	752' 5737	'4484	57	58	'2076	050' 3410
58	'5458	614' 9779	7	805' 0221	'4542	58	56	'2020	057' 5480
58	'5400	622' 5237	8	857' 4763	'4600	58	56	'1964	064' 7500
58	'5342	630' 0637	9	909' 9363	'4658	58	58	'1906	071' 9473
57	'5285	637' 5979	30	18962' 4021	'4715	57	56	'1850	079' 1379
59	'5226	645' 1264	1	19014' 8736	'4774	59	57	'1793	086' 3229
57	'5169	652' 6490	2	067' 3510	'4831	57	56	'1737	093' 5022
58	'5111	660' 1659	3	119' 8341	'4889	58	57	'1680	100' 6759
58	'5053	667' 6770	4	172' 3230	'4947	58	57	'1623	107' 8439
58	'4996	675' 1823	35	224' 8177	'5004	58	56	'1567	115' 0062
58	'4938	682' 6819	6	277' 3181	'5062	58	57	'1510	122' 1629
58	'4880	690' 1757	7	329' 8243	'5120	58	56	'1454	129' 3139
58	'4822	697' 6637	8	382' 3363	'5178	58	57	'1397	136' 4593
57	'4765	705' 1459	9	434' 8541	'5235	57	56	'1341	143' 5990
58	'4707	712' 6224	40	487' 3776	'5293	58	57	'1284	150' 7331
57	'4650	720' 0931	1	539' 9069	'5350	57	56	'1228	157' 8615
58	'4592	727' 5581	2	592' 4419	'5408	58	57	'1171	164' 9843
58	'4534	735' 0173	3	644' 9827	'5466	58	56	'1115	172' 1014
57	'4477	742' 4707	4	697' 5293	'5523	57	57	'1058	179' 2129
58	'4419	749' 9184	45	750' 0816	'5581	58	56	'1002	186' 3187
57	'4362	757' 3603	6	802' 6397	'5638	57	56	'0946	193' 4189
58	'4304	764' 7965	7	855' 2035	'5696	58	57	'0889	200' 5135
57	'4247	772' 2269	8	907' 7731	'5753	57	56	'0833	207' 6024
58	'4189	779' 6516	9	19960' 3484	'5811	58	56	'0777	214' 6857
57	'4132	787' 0705	50	20012' 9295	'5868	57	56	'0721	221' 7634
57	'4075	794' 4837	1	065' 5163	'5925	57	57	'0664	228' 8355
58	'4017	801' 8912	2	118' 1088	'5983	58	56	'0608	235' 9019
57	'3960	809' 2929	3	170' 7071	'6040	57	57	'0551	242' 9627
58	'3902	816' 6889	4	223' 3111	'6098	58	55	'0496	250' 0178
57	'3845	824' 0791	55	275' 9209	'6155	57	57	'0439	257' 0674
58	'3787	831' 4636	6	328' 5364	'6213	58	56	'0383	264' 1113
56	'3731	838' 8423	7	381' 1577	'6269	56	56	'0327	271' 1496
58	'3673	846' 2154	8	433' 7846	'6327	58	56	'0271	278' 1823
58	7' 3615	853' 5827	9	486' 4173	'6385	58	56	'0215	285' 2094
		155860' 9442	60	20539' 0558					156292' 2309

-49°.	Diff.	Δ°.	Δ°.	Diff.	50°.	'	-50°.	Diff.	Δ°.
29539'0558	"	56	56	"	156292'2309	0	23707'7691	"	56
591'6999	52'6441	58	57	7'0159	299'2468	1	760'7532	52'9841	57
644'3498	'6499	57	56	'0102	306'2570	2	813'7430	'9898	56
697'0054	'6556	57	55	7'0046	313'2616	3	866'7384	52'9954	55
749'6667	'6613	57	57	6'9991	320'2607	4	919'7393	53'0009	57
802'3337	'6670	58	55	'9934	327'2541	5	23972'7459	'0066	57
855'0065	'6728	56	57	'9879	334'2420	6	24025'7580	'0121	55
907'6849	'6784	58	55	'9822	341'2242	7	078'7758	'0178	57
20960'3691	'6842	57	57	'9767	348'2009	8	131'7991	'0233	55
21013'0590	'6899	57	55	'9710	355'1719	9	184'8281	'0290	57
	'6956	57	55	'9655				'0345	55
065'7546	'7013	57	56	'9599	362'1374	10	237'8626	'0401	56
118'4559	'7070	57	56	'9543	369'0973	1	290'9027	'0457	56
171'1629	'7127	57	56	'9487	376'0516	2	343'9484	'0513	56
223'8756	'7184	57	56	'9431	383'0003	3	396'9997	'0569	56
276'5940	'7241	57	55	'9375	389'9434	4	450'0566	'0625	56
329'3181	'7298	57	56	'9320	396'8809	15	503'1191	'0680	55
382'0479	'7355	57	56	'9264	403'8129	6	556'1871	'0736	56
434'7834	'7412	57	56	'9208	410'7393	7	609'2607	'0792	56
487'5246	'7468	56	56	'9152	417'6601	8	662'3399	'0848	56
540'2714	'7526	58	56	'9096	424'5753	9	715'4247	'0904	56
593'0240	'7582	56	55	'9041	431'4849	20	768'5151	'0959	55
645'7822	'7640	58	56	'8985	438'3890	1	821'6110	'1015	56
698'5462	'7696	56	55	'8930	445'2875	2	874'7125	'1070	55
751'3158	'7753	57	56	'8874	452'1805	3	927'8195	'1126	56
804'0911	'7810	57	56	'8818	459'0679	4	24980'9321	'1182	56
856'8721	'7866	56	56	'8762	465'9497	25	25034'0503	'1238	56
909'6587	'7924	58	55	'8707	472'8259	6	087'1741	'1293	55
21962'4511	'7980	56	55	'8652	479'6966	7	140'3034	'1348	55
22018'2491	'8036	56	56	'8596	486'5618	8	193'4382	'1404	56
068'0527	'8094	58	56	'8540	493'4214	9	246'5786	'1460	56
120'8621	'8150	56	55	'8485	500'2754	30	299'7246	'1515	55
173'6771	'8207	57	56	'8429	507'1239	1	352'8761	'1571	56
226'1498	'8263	56	55	'8374	513'9668	2	406'0332	'1626	55
279'3241	'8320	57	55	'8319	520'8042	3	459'1958	'1681	55
332'1561	'8377	57	56	'8263	527'6361	4	512'3639	'1737	56
384'9938	'8433	56	56	'8207	534'4624	35	565'5376	'1793	56
437'8371	'8490	57	54	'8153	541'2831	6	618'7169	'1847	54
490'6861	'8546	56	56	'8097	548'0984	7	671'9016	'1903	56
543'5407	'8603	57	56	'8041	554'9081	8	725'0919	'1959	56
596'4010	'8659	56	55	'7986	561'7122	9	778'2878	'2014	55
649'2669	'8716	57	55	'7931	568'5108	40	831'4892	'2069	55
702'1385	'8772	56	55	'7876	575'3039	1	884'6961	'2124	55
755'0157	'8829	57	56	'7820	582'0915	2	937'9085	'2180	56
807'8986	'8885	56	55	'7765	588'8735	3	25991'1265	'2235	55
860'7871	'8942	57	55	'7710	595'6500	4	26044'3500	'2290	55
913'6813	'8998	56	55	'7655	602'4210	45	097'5790	'2345	55
22966'5811	'9054	56	56	'7599	609'1865	6	150'8135	'2401	56
23019'4865	'9111	57	55	'7544	615'9464	7	204'0536	'2456	55
072'3976	'9167	56	55	'7489	622'7008	8	257'2992	'2511	55
125'3143	'9223	56	55	'7434	629'4497	9	310'5503	'2566	55
178'2366	'9279	56	55	'7379	636'1931	50	363'8069	'2621	55
231'1645	'9336	57	55	'7324	642'9310	1	417'0690	'2676	55
284'0981	'9392	56	55	'7269	649'6634	2	470'3366	'2731	55
337'0373	'9449	57	56	'7213	656'3903	3	523'6097	'2787	56
398'9822	'9504	55	54	'7159	663'1116	4	576'8884	'2841	54
442'9326	'9561	57	56	'7103	669'8275	55	630'1725	'2897	56
495'8887	'9617	56	54	'7049	676'5378	6	683'4622	'2951	54
548'8504	'9673	56	56	'6993	683'2427	7	736'7573	'3007	56
601'8177	'9729	56	54	'6939	689'9420	8	790'0580	'3061	54
654'7906	'9785	56	55	6'6884	696'6359	9	843'3641	'3116	55
23707'7691	52'9785				156703'3243	60	26896'6757		

Δ°.	Diff.	51°.		-51°.	Diff.	Δ°.	Δ°	Diff.	52°.
56	"	"	0	26896''6757	"	56	54	"	157094''647
54	6'6828	156703'3243	1	26949'9929	53'3172	54	54	6'3570	101'004
55	'6774	710'0071	2	27003'3155	'3226	55	54	'3516	107'356
55	'6719	716'6845	3	27056'6436	'3281	55	54	'3462	113'702
55	'6664	723'3564	4	109'9772	'3336	55	53	'3409	120'043
55	'6609	730'0228	5	163'3163	'3391	55	54	'3355	126'378
54	'6555	736'6837	6	216'6608	'3445	54	53	'3302	132'708
55	'6500	743'3392	7	270'0108	'3500	55	54	'3248	139'033
56	'6444	749'9892	8	323'3664	'3556	56	53	'3194	145'353
54	'6390	756'6336	9	376'7274	'3610	54	54	'3141	151'667
54	'6336	763'2726			'3664			'3087	
55	'6281	769'9062	10	430'0938	'3719	55	53	'3034	157'975
55	'6226	776'5343	1	483'4657	'3774	55	54	'2980	164'279
55	'6171	783'1569	2	536'8431	'3829	55	53	'2927	170'577
54	'6117	789'7740	3	590'2260	'3883	54	54	'2873	176'870
55	'6062	796'3857	4	643'6143	'3938	55	53	'2820	183'157
55	'6007	802'9919	15	697'0081	'3993	55	53	'2767	189'439
54	'5953	809'5926	6	750'4074	'4047	54	54	'2713	195'716
55	'5898	816'1879	7	803'8121	'4102	55	54	'2659	201'987
55	'5843	822'7777	8	857'2223	'4157	55	53	'2606	208'253
54	'5789	829'3620	9	910'6380	'4211	54	53	'2553	214'513
54	'5735	835'9409	20	27964'0591	'4265	54	53	'2500	220'769
55	'5680	842'5144	1	28017'4856	'4320	55	54	'2446	227'019
54	'5626	849'0824	2	070'9176	'4374	54	53	'2393	233'263
55	'5571	855'6450	3	124'3550	'4429	55	53	'2340	239'503
55	'5516	862'2021	4	177'7979	'4484	55	54	'2286	245'737
54	'5462	868'7537	25	231'2403	'4538	54	52	'2234	251'965
54	'5408	875'2999	6	284'7001	'4592	54	54	'2180	258'189
54	'5354	881'8407	7	338'1593	'4646	54	53	'2127	264'407
55	'5299	888'3761	8	391'6239	'4701	55	54	'2073	270'619
55	'5244	894'9060	9	445'0940	'4756	55	52	'2021	276'827
53	'5191	901'4304	30	498'5696	'4809	53	53	'1968	283'029
55	'5136	907'9495	1	552'0505	'4864	55	54	'1914	289'225
54	'5082	914'4631	2	605'5369	'4918	54	53	'1861	295'417
55	'5027	920'9713	3	659'0287	'4973	55	53	'1808	301'603
53	'4974	927'4740	4	712'5260	'5026	53	53	'1755	307'784
55	'4919	933'9714	35	766'0286	'5081	55	53	'1702	313'959
55	'4864	940'4633	6	819'5367	'5136	55	52	'1650	320'129
53	'4811	946'9497	7	873'0503	'5189	53	54	'1596	326'294
54	'4757	953'4308	8	926'5692	'5243	54	53	'1543	332'454
55	'4702	959'9065	9	28980'0935	'5298	55	53	'1490	338'608
54	'4648	966'3767	40	29033'6233	'5352	54	53	'1437	344'757
53	'4593	972'8415	1	087'1585	'5405	53	52	'1385	350'901
55	'4540	979'3010	2	140'6990	'5460	55	54	'1331	357'040
55	'4485	985'7550	3	194'2450	'5515	55	52	'1279	363'173
53	'4432	992'2035	4	247'7965	'5568	53	53	'1226	369'301
54	'4378	156998'6467	45	301'3533	'5622	54	53	'1177	375'423
54	'4324	157005'0845	6	354'9155	'5676	54	53	'1120	381'540
54	'4270	011'5169	7	408'4831	'5730	54	53	'1067	387'652
54	'4216	017'9439	8	462'0561	'5784	54	52	'1015	393'759
54	'4162	024'3655	9	515'6345	'5838	54	53	'0962	399'861
54	'4108	030'7817	50	569'2183	'5892	54	53	'0909	405'957
54	'4054	037'1925	1	622'8075	'5946	54	52	'0857	412'048
54	'4000	043'5979	2	676'4021	'6000	54	53	'0804	418'133
53	'3947	049'9979	3	730'0021	'6053	53	53	'0751	424'214
54	'3893	056'3926	4	783'6074	'6107	54	53	'0698	430'289
55	'3838	062'7819	55	837'2181	'6162	55	52	'0646	436'359
53	'3785	069'1657	6	890'8343	'6215	53	53	'0593	442'428
55	'3732	075'5442	7	944'4558	'6268	55	52	'0541	448'483
55	'3677	081'9174	8	29998'0826	'6323	55	53	'0488	454'537
53	6'3624	088'2851	9	30051'7149	'6376	53	52	'0436	460'586
		157094'6475	60	30105'3525					157466'6296

-52°	Diff.	Δ°	Δ°	Diff.	53°	-53°	Diff.	Δ°
30105 "3525	"	"	"	"	157466 "6296	33333 "3704	"	"
158 "9955	53 "6430	54	53	6 "0383	472 "6679	1	53 "9617	53
212 "6439	"6484	54	53	"0330	478 "7009	2	"9670	52
266 "2977	"6538	54	52	"0278	484 "7287	3	"9722	52
319 "9568	"6591	53	52	"0226	490 "7513	4	"9774	53
373 "6213	"6645	54	53	"0173	496 "7686	5	"9827	52
427 "2911	"6698	53	52	"0121	502 "7807	6	"9879	52
480 "9663	"6752	54	53	"0069	508 "7876	7	"9931	53
534 "6469	"6806	54	53	6 "0016	514 "7892	8	53 "9984	53
588 "3328	"6859	53	53	5 "9963	520 "7855	9	54 "0037	53
	"6913	54	51	"9912			"0088	51
642 "0241	"6966	53	53	"9859	526 "7767	10	873 "2233	53
695 "7207	"7020	54	53	"9806	532 "7626	1	927 "2374	53
749 "4227	"7073	53	51	"9755	538 "7432	2	33981 "2568	51
803 "1300	"7127	54	53	"9702	544 "7187	3	34035 "2813	53
856 "8427	"7180	53	52	"9650	550 "6889	4	089 "3111	52
910 "5607	"7233	54	52	"9598	556 "6539	5	143 "3461	52
30964 "2840	"7287	53	53	"9545	562 "6137	6	197 "3863	53
31018 "0127	"7341	54	51	"9494	568 "5682	7	251 "4318	51
071 "7468	"7394	53	53	"9441	574 "5176	8	305 "4824	53
125 "4862	"7447	53	52	"9389	580 "4617	9	359 "5383	52
179 "2309	"7500	53	52	"9337	586 "4006	20	413 "5994	52
232 "9809	"7554	54	52	"9285	592 "3343	1	467 "6657	52
286 "7363	"7607	53	52	"9233	598 "2628	2	521 "7372	52
340 "4970	"7660	53	52	"9181	604 "1861	3	575 "8139	52
394 "2630	"7714	54	53	"9128	610 "1042	4	629 "8958	53
448 "0344	"7766	52	51	"9077	616 "0170	25	683 "9830	52
501 "8110	"7820	54	52	"9025	621 "9247	6	738 "0753	51
555 "5930	"7873	53	53	"8972	627 "8272	7	792 "1728	53
609 "3803	"7927	54	51	"8921	633 "7244	8	846 "2756	51
663 "1730	"7979	52	52	"8869	639 "6165	9	900 "3835	52
716 "9709	"8032	53	52	"8817	645 "5034	30	34954 "4966	52
770 "7741	"8086	54	52	"8765	651 "3851	1	35008 "6149	52
824 "5827	"8139	53	51	"8714	657 "2616	2	062 "7384	51
878 "3966	"8192	53	53	"8661	663 "1330	3	116 "8670	53
932 "2158	"8245	53	51	"8610	668 "9991	4	171 "0009	51
31986 "0403	"8298	53	53	"8557	674 "8601	35	225 "1399	53
32039 "8701	"8350	52	51	"8506	680 "7158	6	279 "2842	51
093 "7051	"8404	54	52	"8454	686 "5664	7	333 "4336	52
147 "5455	"8457	53	51	"8403	692 "4118	8	387 "5882	51
201 "3912	"8510	53	52	"8351	698 "2521	9	441 "7479	52
255 "2422	"8563	53	52	"8299	704 "0872	40	495 "9128	52
309 "0985	"8615	52	52	"8247	709 "9171	1	550 "0829	52
362 "9600	"8669	54	51	"8196	715 "7418	2	604 "2582	51
416 "8269	"8721	52	52	"8144	721 "5614	3	658 "4386	52
470 "6990	"8774	53	52	"8092	727 "3758	4	712 "6242	52
524 "5764	"8827	53	51	"8041	733 "1850	45	766 "8150	51
578 "4591	"8880	53	52	"7989	738 "9891	6	821 "0109	52
632 "3471	"8933	53	51	"7938	744 "7880	7	875 "2120	51
686 "2404	"8985	52	52	"7886	750 "5818	8	929 "4182	52
740 "1389	"9038	53	51	"7835	756 "3704	9	35983 "6296	51
794 "0427	"9091	53	52	"7783	762 "1539	50	36037 "8461	52
847 "9518	"9143	52	52	"7731	767 "9322	1	092 "0678	52
901 "8661	"9196	53	51	"7680	773 "7953	2	146 "2947	51
32955 "7857	"9249	53	51	"7629	779 "4733	3	200 "5267	51
33009 "7106	"9302	53	51	"7578	785 "2362	4	254 "7638	51
063 "6408	"9354	52	52	"7526	790 "9940	55	309 "0060	52
117 "5762	"9407	53	52	"7474	796 "7466	6	363 "2534	52
171 "5169	"9459	53	51	"7423	802 "4940	7	417 "5060	51
225 "4628	"9512	52	51	"7372	808 "2363	8	471 "7637	51
279 "4140	"9564	52	51	"7321	813 "9735	9	526 "0265	51
33333 "3704	53 "9564		51	5 "7321	157819 "7056	60	36580 "2944	54

Δ° .	Diff.	54° .		-54° .	Diff.	Δ° .	Δ° .	Diff.	55° .					
52	"	157819	"	7056	0	36580	"	2944	"					
51	5'7269	825	4325	1	634	5675	54	2731	52	49	"	158154	"	3162
51	7218	831	1543	2	688	8457	2782	51	51	5	4230	159	7392	
51	7167	836	8710	3	743	1290	2833	51	49	4	4179	165	1571	
50	7115	842	5825	4	797	4175	2885	50	50	4	4130	170	5701	
52	7065	848	2890	5	851	7110	2935	52	49	4	4079	175	9780	
51	7013	853	9903	6	906	0097	2987	51	51	3	4029	181	3800	
52	6962	859	6865	7	960	6031	3038	51	51	3	3980	186	7780	
50	6910	865	3775	8	36960	3135	3090	52	49	3	3929	192	1718	
51	6860	871	0635	9	37014	6225	3140	50	51	3	3880	197	5598	
	6809	876	7444	10	068	9365	3191	51	49	3	3829	202	9427	
52	6757	882	4201	1	123	2556	3243	52	50	3	3780	208	3207	
51	6706	888	0907	2	177	5799	3294	51	50	3	3730	213	6937	
50	6656	893	7563	3	231	9093	3344	50	49	3	3680	219	0617	
52	6604	899	4167	4	286	2437	3396	52	51	3	3631	224	4248	
51	6553	905	0720	15	340	5833	3447	51	49	3	3580	229	7828	
52	6503	910	7223	6	394	9280	3497	50	50	3	3531	235	1359	
51	6451	916	3674	7	449	2777	3549	52	50	3	3481	240	4840	
50	6400	922	0074	8	503	6326	3600	51	49	3	3431	245	8271	
51	6350	927	6424	9	557	9926	3650	50	50	3	3382	251	1653	
	6299	933	2723	20	612	3576	3701	51	50	3	3332	256	4985	
52	6247	938	8970	1	666	7277	3753	52	49	3	3282	261	8267	
50	6197	944	1567	2	721	1030	3803	50	50	3	3233	267	1500	
51	6146	950	1313	3	775	4833	3854	51	50	3	3183	272	4683	
51	6095	955	7408	4	829	8687	3905	51	49	3	3133	277	7816	
50	6045	961	3453	25	884	2592	3955	50	50	3	3084	283	0900	
52	5993	966	9446	6	938	6547	4007	52	49	3	3034	288	3934	
51	5943	972	5389	7	37993	0554	4057	50	50	3	2985	293	6619	
50	5892	978	1281	8	38047	4611	4108	51	49	3	2935	298	9854	
52	5842	983	7123	9	101	8719	4158	50	49	3	2886	304	2740	
	5790	989	2913	30	156	2877	4210	52	50	3	2837	309	5577	
50	5740	157994	8653	1	210	7087	4260	50	50	3	2787	314	8364	
52	5690	158000	4343	2	265	1347	4310	50	49	3	2737	320	1101	
50	5638	005	9981	3	319	5657	4362	52	49	3	2688	325	3789	
51	5588	011	5569	4	374	0019	4412	50	50	3	2639	330	6428	
51	5538	017	1107	35	428	4431	4462	50	49	3	2589	335	9017	
50	5487	022	6594	6	482	8893	4513	51	50	3	2540	341	1557	
51	5436	028	2030	7	537	3406	4564	51	48	3	2490	346	4047	
51	5386	033	7416	8	591	7970	4614	50	50	3	2442	351	6489	
50	5335	039	2751	9	646	2584	4665	51	50	3	2392	356	8881	
	5285	044	8036	40	700	7249	4715	50	48	3	2342	362	1223	
50	5235	050	3271	1	755	1964	4765	50	50	3	2294	367	3517	
51	5184	055	8455	2	809	6729	4816	51	49	3	2244	372	5761	
50	5133	061	3588	3	864	1545	4867	51	49	3	2195	377	7956	
50	5083	066	8671	4	918	6412	4917	50	49	3	2146	383	0100	
51	5033	072	3704	45	38973	1329	4967	50	49	3	2097	388	2199	
50	4982	077	8686	6	39027	6296	5018	51	50	3	2048	393	4247	
50	4932	083	3618	7	082	1314	5068	50	48	3	2000	398	6245	
51	4882	088	8500	8	136	6382	5118	50	50	3	1950	403	8195	
51	4831	094	3331	9	191	1500	5169	51	49	3	1900	409	0095	
50	4781	099	8112	50	245	6669	5219	50	48	3	1851	414	1946	
50	4731	105	2843	1	300	1888	5269	50	50	3	1803	419	3749	
51	4681	110	7524	2	354	7157	5319	50	49	3	1753	424	5502	
50	4630	116	2154	3	409	2476	5370	51	48	3	1704	429	7206	
50	4580	121	6734	4	463	7846	5420	50	50	3	1656	434	8862	
50	4530	127	1264	55	518	3266	5470	50	49	3	1606	440	0468	
50	4480	132	5744	6	572	8736	5520	50	48	3	1557	445	2025	
50	4430	138	0174	7	627	4256	5570	50	50	3	1509	450	3534	
51	4380	143	4554	8	681	9826	5620	50	48	3	1459	455	4993	
50	4329	148	8883	9	736	5446	5671	51	49	3	1411	460	6404	
54	4279	158154	3162	60	791	1117	5721	50	49	3	1362	465	7766	
					39845	6838					51313	158470	9079	

	-55°.	Diff.	Δ°.	Δ°.	Diff.	56°.		-56°.	Diff.	Δ°.
0	39845 ⁶⁸³⁸	"		48	"	158470 ⁹⁰⁷⁹	0	43129 ⁹⁰²¹	"	48
1	900 ²⁶⁰⁸	54 ⁵⁷⁷⁰	49	50	5 ¹²⁶⁵	476 ⁰³⁴⁴	1	183 ⁹⁶⁵⁶	54 ⁸⁷³⁵	50
2	39954 ⁸⁴²⁹	5821	51	50	1215	481 ¹⁵⁵⁹	2	238 ⁸⁴⁴¹	8785	48
3	40009 ⁴²⁹⁹	5870	49	48	1167	486 ²⁷²⁶	3	293 ⁷²⁷⁴	8833	49
4	064 ⁰²²⁰	5921	51	49	1118	491 ³⁸⁴⁴	4	348 ⁶¹⁵⁶	8882	48
5	118 ⁶¹⁹¹	5971	50	48	1070	496 ⁴⁹¹⁴	5	403 ⁵⁰⁸⁶	8930	48
6	173 ²²¹¹	6020	51	48	1020	501 ⁵⁹³⁴	6	458 ⁴⁰⁶⁶	8980	50
7	227 ⁸²⁸²	6071	49	49	0972	506 ⁶⁹⁰⁶	7	513 ³⁰⁹⁴	9028	48
8	282 ⁴⁴⁰²	6120	51	48	0923	511 ⁷⁸²⁹	8	568 ²¹⁷¹	9077	49
9	337 ⁰⁵⁷³	6171	49	49	0875	516 ⁸⁷⁰⁴	9	623 ¹²⁹⁶	9125	48
		6220			0826				9174	49
0	391 ⁶⁷⁹³	6270	50	48	0778	521 ⁹⁵³⁰	10	678 ⁰⁴⁷⁰	9222	48
1	446 ³⁰⁶³	6320	50	49	0729	527 ⁰³⁰⁸	1	732 ⁹⁶⁹²	9271	49
2	500 ⁹³⁸³	6369	49	49	0680	532 ¹⁰³⁷	2	787 ⁸⁹⁶³	9320	49
3	555 ⁵⁷⁵²	6420	51	48	0632	537 ¹⁷¹⁷	3	842 ⁸²⁸³	9368	48
4	610 ²¹⁷²	6469	49	49	0583	542 ²³⁴⁹	4	897 ⁷⁶⁵¹	9417	49
5	664 ⁸⁶¹¹	6519	50	48	0535	547 ²⁹³²	5	952 ⁷⁰⁶⁸	9465	48
6	719 ⁵¹⁶⁰	6569	50	48	0487	552 ³⁴⁶⁷	6	1007 ⁶⁵³³	9513	48
7	774 ¹⁷²⁹	6618	49	49	0438	557 ³⁹⁵⁴	7	1062 ⁶⁰⁴⁶	9562	49
8	828 ⁸³⁴⁷	6668	50	49	0389	562 ⁴³⁹²	8	1117 ⁵⁶⁰⁸	9611	49
9	883 ⁵⁰¹⁵	6718	50	48	0341	567 ⁴⁷⁸¹	9	1172 ⁵²¹⁹	9659	48
0	938 ¹⁷³³	6767	49	48	0293	572 ⁵¹²²	20	227 ⁴⁸⁷⁸	9707	48
1	40992 ⁸⁵⁰⁰	6817	50	48	0245	577 ⁵⁴¹⁵	1	282 ⁴⁵⁸⁵	9755	48
2	41047 ⁵³¹⁷	6867	50	49	0196	582 ⁵⁶⁶⁰	2	337 ⁴³⁴⁰	9804	49
3	102 ²¹⁸⁴	6916	49	49	0147	587 ⁵⁸⁵⁶	3	392 ⁴¹⁴⁴	9853	49
4	156 ⁹¹⁰⁰	6966	50	47	0100	592 ⁶⁰⁰³	4	447 ³⁹⁹⁷	9900	47
5	211 ⁶⁰⁶⁶	7015	49	49	0051	597 ⁶¹⁰³	25	502 ³⁸⁹⁷	9949	49
6	266 ³⁰⁸¹	7065	50	48	5 ⁰⁰⁰³	602 ⁶¹⁵⁴	6	557 ³⁸⁴⁶	9997	48
7	321 ⁰¹⁴⁶	7114	49	49	4 ⁹⁹⁵⁵	607 ⁶¹⁵⁷	7	612 ³⁸⁴³	54 ⁹⁹⁹⁷	48
8	375 ⁷²⁶⁰	7163	49	49	9906	612 ⁶¹¹²	8	667 ³⁸⁸⁸	55 ⁰⁰⁴⁵	49
9	430 ⁴⁴²³	7213	50	47	9859	617 ⁶⁰¹⁸	9	722 ³⁹⁸²	0141	47
0	485 ¹⁶³⁶	7263	50	49	9810	622 ⁵⁸⁷⁷	30	777 ⁴¹²³	0190	49
1	539 ⁸⁸⁹⁹	7312	49	48	9762	627 ⁵⁶⁸⁷	1	832 ⁴³¹³	0238	48
2	594 ⁶²¹¹	7361	49	48	9714	632 ⁵⁴⁴⁹	2	887 ⁴⁵⁵¹	0286	48
3	649 ³⁵⁷²	7411	50	49	9665	637 ⁵¹⁶³	3	942 ⁴⁸³⁷	0335	49
4	704 ⁰⁹⁸³	7460	49	47	9618	642 ⁴⁸²⁸	4	997 ⁵¹⁷²	0382	47
5	758 ⁸⁴⁴³	7510	50	48	9570	647 ⁴⁴⁴⁶	35	1052 ⁵⁵⁵⁴	0430	48
6	813 ⁵⁹⁵³	7558	48	48	9522	652 ⁴⁰¹⁶	6	107 ⁵⁹⁸⁴	0478	48
7	868 ³⁵¹¹	7608	50	49	9473	657 ³⁵³⁸	7	162 ⁴⁶⁴²	0527	49
8	923 ¹¹¹⁹	7658	50	47	9426	662 ³⁰¹¹	8	217 ⁶⁹⁸⁹	0574	47
9	41977 ⁸⁷⁷⁷	7706	48	49	9377	667 ²⁴³⁷	9	272 ⁷⁵⁶³	0623	49
0	42032 ⁶⁴⁸³	7756	50	47	9330	672 ¹⁸¹⁴	40	327 ⁸¹⁸⁶	0670	47
1	087 ⁴²³⁹	7805	49	48	9282	677 ¹¹⁴⁴	1	382 ⁸⁸⁵⁶	0718	48
2	142 ²⁰⁴⁴	7854	49	48	9234	682 ⁰⁴²⁶	2	437 ⁹⁵⁷⁴	0766	48
3	196 ⁹⁸⁹⁸	7903	49	48	9186	686 ⁹⁶⁶⁰	3	493 ⁰³⁴⁰	0814	48
4	251 ⁷⁸⁰¹	7952	49	48	9138	691 ⁸⁸⁴⁶	4	548 ¹¹⁵⁴	0862	48
5	306 ⁵⁷⁵³	8002	50	48	9090	696 ⁷⁹⁸⁴	45	603 ²⁰¹⁶	0910	48
6	361 ³⁷⁵⁵	8050	48	48	9042	701 ⁷⁰⁷⁴	6	658 ²⁹²⁶	0958	48
7	416 ¹⁸⁰⁵	8100	50	47	8995	706 ⁶¹¹⁶	7	713 ³⁸⁸⁴	1005	47
8	470 ⁹⁹⁰⁵	8149	49	48	8947	711 ⁵¹¹¹	8	768 ⁴⁸⁸⁹	1053	48
9	525 ⁸⁰⁵⁴	8197	48	48	8899	716 ⁴⁰⁵⁸	9	823 ⁵⁹⁴²	1101	48
0	580 ⁶²⁵¹	8247	50	48	8851	721 ²⁹⁵⁷	50	878 ⁷⁰⁴³	1149	48
1	635 ⁴⁴⁹⁸	8296	49	47	8804	726 ¹⁸⁰⁸	1	933 ⁸¹⁹²	1196	47
2	690 ²⁷⁹⁴	8344	48	48	8756	731 ⁰⁶¹²	2	988 ⁹³⁸⁸	1244	48
3	745 ¹¹³⁸	8394	50	48	8708	735 ⁹³⁶⁸	3	1044 ⁰⁶³²	1292	48
4	799 ⁹⁵³²	8443	49	48	8660	740 ⁸⁰⁷⁶	4	1099 ¹⁹²⁴	1340	48
5	854 ⁷⁹⁷⁵	8491	48	47	8613	745 ⁶⁷³⁶	55	154 ³²⁶⁴	1387	47
6	909 ⁶⁴⁶⁶	8541	50	47	8566	750 ⁵³⁴⁹	6	209 ⁴⁶⁵¹	1434	47
7	42964 ⁵⁰⁰⁷	8589	48	48	8518	755 ³⁹¹⁵	7	264 ⁶⁰⁸⁵	1482	48
8	43019 ³⁵⁹⁶	8638	49	48	8470	760 ²⁴³³	8	319 ⁷⁵⁶⁷	1530	48
9	074 ²²³⁴	8687	49	48	8422	765 ⁰⁹⁰³	9	374 ⁹⁰⁹⁷	1578	48
0	43129 ⁰⁹²¹					158769 ⁹³²⁵	60	46430 ⁰⁶⁷⁵		

Δ^2 .	Diff.	57° .	'	-57° .	Diff.	Δ^2 .	Δ^2 .	Diff.	58° .
47	"	158769	0	46430	"	47	"	159051	"8472
47	4'8375	774'7700	1	485'2300	55'1625	47	4'	5562	056'4034
47	'8328	779'6028	2	540'3972	'1672	47	'46	'5516	060'9550
48	'8280	784'4308	3	595'5692	'1720	48	'46	'5470	065'5020
47	'8232	789'2540	4	650'7460	'1768	47	'46	'5424	070'0444
47	'8185	794'0725	5	705'9275	'1815	47	'46	'5378	074'5822
47	'8138	798'8863	6	761'1137	'1862	47	'46	'5332	079'1154
47	'8091	803'6954	7	816'3046	'1909	48	'46	'5285	083'6439
48	'8043	808'4997	8	871'5003	'1957	48	'45	'5239	088'1678
46	'7995	813'2992	9	926'7008	'2005	46	'47	'5194	092'6872
	'7949				'2051			'5147	
48	'7901	818'0941	10	46981'9059	'2099	48	'46	'5101	097'2019
48	'7853	822'8842	1	47037'1158	'2147	48	'46	'5055	101'7120
47	'7806	827'6695	2	092'3305	'2194	47	'46	'5009	106'2175
46	'7760	832'4501	3	147'5499	'2240	46	'45	'4964	110'7184
48	'7712	837'2261	4	202'7739	'2288	48	'47	'4917	115'2148
48	'7664	841'9973	15	258'0027	'2336	48	'46	'4871	119'7065
46	'7618	846'7637	6	313'2363	'2382	46	'45	'4826	124'1936
48	'7570	851'5255	7	368'4745	'2430	48	'47	'4779	128'6762
47	'7523	856'2825	8	423'7175	'2477	47	'45	'4734	133'1541
47	'7476	861'0348	9	478'9652	'2524	47	'46	'4688	137'6275
47	'7429	865'7824	20	534'2176	'2571	47	'46	'4642	142'0963
47	'7382	870'5253	1	589'4747	'2618	47	'46	'4596	146'5605
47	'7335	875'2635	2	644'7365	'2665	47	'45	'4551	151'0201
47	'7288	879'9970	3	700'0030	'2712	47	'46	'4505	155'4752
47	'7241	884'7258	4	755'2742	'2759	47	'46	'4459	159'9257
48	'7193	889'4499	25	810'5501	'2807	48	'46	'4413	164'3716
46	'7147	894'1692	6	865'8308	'2853	46	'45	'4368	168'8129
47	'7100	898'8839	7	921'1161	'2900	47	'46	'4322	173'2497
47	'7053	903'5939	8	47976'4061	'2947	47	'46	'4276	177'6819
47	'7006	908'2992	9	48031'7008	'2994	47	'45	'4231	182'1095
47	'6959	912'9998	30	087'0002	'3041	47	'46	'4185	186'5326
47	'6912	917'6957	1	142'3043	'3088	47	'45	'4140	190'9511
46	'6866	922'3869	2	197'6131	'3134	46	'46	'4094	195'3651
48	'6818	927'0735	3	252'9265	'3182	48	'46	'4048	199'7745
46	'6772	931'7553	4	308'2447	'3228	46	'45	'4003	204'1793
47	'6725	936'4325	35	363'5675	'3275	47	'45	'3958	208'5796
46	'6679	941'1050	6	418'8950	'3321	46	'46	'3912	212'9754
48	'6631	945'7729	7	474'2271	'3369	48	'46	'3866	217'3666
46	'6585	950'4360	8	529'5640	'3415	46	'45	'3821	221'7532
47	'6538	955'0945	9	584'9055	'3462	47	'45	'3776	226'1353
47	'6491	959'7483	40	640'2517	'3509	47	'45	'3731	230'5129
46	'6445	964'3974	1	695'6026	'3555	46	'46	'3685	234'8860
47	'6398	969'0419	2	750'9581	'3602	47	'46	'3639	239'2515
46	'6352	973'6817	3	806'3183	'3648	46	'44	'3595	243'6184
47	'6305	978'3169	4	861'6831	'3695	47	'46	'3549	247'9779
47	'6258	982'9474	45	917'0526	'3742	47	'45	'3504	252'3328
46	'6212	987'5732	6	48972'4268	'3788	46	'46	'3458	256'6832
47	'6165	992'1944	7	49027'8056	'3835	47	'44	'3414	261'0290
46	'6119	158996'8109	8	083'1891	'3881	46	'46	'3368	265'3704
47	'6072	159001'4228	9	138'5772	'3928	47	'45	'3323	269'7072
46	'6026	006'0300	50	193'9700	'3974	46	'46	'3277	274'0395
47	'5980	010'6326	1	249'3674	'4020	47	'44	'3233	278'3672
47	'5933	015'2306	2	304'7694	'4067	47	'45	'3188	282'6905
47	'5886	019'8239	3	360'1761	'4114	47	'46	'3142	287'0093
46	'5840	024'4125	4	415'5875	'4160	46	'45	'3097	291'3235
46	'5794	028'9965	55	471'0035	'4206	46	'45	'3052	295'6332
46	'5748	033'5759	6	526'4241	'4252	46	'44	'3008	299'9384
47	'5701	038'1507	7	581'8493	'4299	47	'46	'2962	304'2392
46	'5655	042'7208	8	637'2792	'4345	46	'45	'2917	308'5354
46	4'5609	047'2863	9	692'7137	55'4391	46	'44	4'2873	312'8271
		159051'8472	60	49748'1528					159317'1144

	-59° .	Diff.	Δ° .	Δ° .	Diff.	59° .		-59°	Diff.	Δ° .
00	49748''1528	"		46	"	159317''1144	0	53082''8856	"	46
01	803'5966	55'4438	47	45	4'2827	321'3971	1	138'6029	55'7173	45
02	859'0450.	'4484	46	44	'2782	325'6753	2	194'3247	'7218	44
03	914'4980	'4530	46	46	'2738	329'9491	3	250'0509	'7262	46
04	49969'9556	'4576	46	44	'2692	334'2183	4	305'7817	'7308	44
05	50025'4178	'4622	46	45	'2648	338'4831	5	361'5169	'7352	45
06	080'8846	'4668	46	45	'2603	342'7434	6	417'2566	'7397	45
07	136'3561	'4715	47	44	'2558	346'9992	7	473'0008	'7442	44
08	191'8322	'4761	46	46	'2514	351'2506	8	528'7494	'7486	46
09	247'3128	'4806	45	44	'2468	355'4974	9	584'5026	'7532	44
		'4853	47		'2424				'7576	
10	302'7981	'4899	46	45	'2379	359'7398	10	640'2602	'7621	45
11	358'2880	'4945	46	44	'2335	363'9777	1	696'0223	'7665	44
12	413'7825	'4991	46	46	'2289	368'2112	2	751'7888	'7711	46
13	469'2816	'5036	45	44	'2245	372'4401	3	807'5599	'7755	44
14	524'7852	'5083	47	44	'2201	376'6646	4	863'3354	'7799	44
15	580'2935	'5129	46	45	'2156	380'8847	15	919'1553	'7844	45
16	635'8064	'5174	45	45	'2111	385'1003	6	53974'8997	'7889	45
17	691'3238	'5221	47	45	'2066	389'3114	7	54030'6886	'7934	45
18	746'8159	'5266	45	44	'2022	393'5180	8	086'4820	'7978	44
19	802'3725	'5312	46	44	'1978	397'7202	9	142'2798	'8022	44
20	857'9037	'5358	46	45	'1933	401'9180	20	198'0820	'8067	45
21	913'4395	'5404	46	45	'1888	406'1113	1	253'8887	'8112	45
22	50968'9799	'5449	45	44	'1844	410'3001	2	309'6999	'8156	44
23	51024'5248	'5495	46	44	'1800	414'4845	3	365'5155	'8200	44
24	080'0743	'5541	46	45	'1755	418'6645	4	421'3355	'8245	45
25	135'6284	'5587	46	44	'1711	422'8400	25	477'1600	'8289	44
26	191'1871	'5632	45	45	'1666	427'0111	6	532'9889	'8334	45
27	246'7503	'5678	46	44	'1622	431'1777	7	588'8223	'8378	44
28	302'3181	'5724	46	44	'1578	435'3399	8	644'6601	'8422	44
29	357'8905	'5769	45	45	'1533	439'4977	9	700'5023	'8467	45
30	413'4674	'5815	46	44	'1489	443'6510	30	756'3490	'8511	44
31	469'0489	'5860	45	44	'1445	447'7999	1	812'2001	'8555	44
32	524'6349	'5906	46	44	'1401	451'9444	2	868'0556	'8599	44
33	580'2255	'5952	46	45	'1356	456'0845	3	923'9155	'8644	45
34	635'8207	'5997	45	43	'1313	460'2201	4	54979'7799	'8687	43
35	691'4204	'6042	45	45	'1268	464'3514	35	55035'6486	'8732	45
36	747'0246	'6088	46	45	'1223	468'4782	6	091'5218	'8777	45
37	802'6334	'6134	46	43	'1180	472'6005	7	147'3995	'8820	43
38	858'2468	'6179	45	44	'1136	476'7185	8	203'2815	'8864	44
39	913'8647	'6224	45	45	'1091	480'8321	9	259'1679	'8909	45
40	51969'4871	'6269	45	44	'1047	484'9412	40	315'0588	'8953	44
41	52025'1140	'6315	46	43	'1004	489'0459	1	370'9541	'8996	43
42	080'7155	'6361	46	45	'0959	493'1463	2	426'8537	'9041	45
43	136'3816	'6405	44	43	'0916	497'2422	3	482'7578	'9084	43
44	192'0221	'6451	46	45	'0871	501'3338	4	538'6662	'9129	45
45	247'6672	'6496	45	44	'0827	505'4209	45	594'5791	'9173	44
46	303'3168	'6542	46	43	'0784	509'5036	6	650'4964	'9216	43
47	358'9710	'6586	44	45	'0739	513'5820	7	706'4180	'9261	45
48	414'6296	'6632	46	44	'0695	517'6559	8	762'3441	'9305	44
49	470'2928	'6677	45	43	'0652	521'7254	9	818'2746	'9348	43
50	525'9605	'6723	46	44	'0608	525'7906	50	874'2094	'9392	44
51	581'6328	'6767	44	44	'0564	529'8514	1	930'1486	'9436	44
52	637'3095	'6812	45	43	'0521	533'9078	2	55986'0922	'9479	43
53	692'9907	'6858	46	45	'0476	537'9599	3	56042'0401	'9524	45
54	748'6765	'6903	45	43	'0433	542'0075	4	097'9925	'9567	43
55	804'3668	'6948	45	44	'0389	546'0508	55	153'9492	'9611	44
56	860'0616	'6992	44	44	'0345	550'0897	6	209'9103	'9655	44
57	915'7608	'7038	46	44	'0301	554'1242	7	255'8758	'9699	44
58	52971'4646	'7083	45	43	'0258	558'1543	8	321'8457	'9742	43
59	53027'1729	'7127	44	43	'0215	562'1801	9	377'8199	'9785	43
60	53082'8856					159566'2016	60	56433'7984		

Δ° .	Diff.	60° .	'	-60° .	Diff.	Δ° .	Δ° .	Diff.	61° .
45	"	159566	0	56433	"	45	42	"	159799
43	4'0170	570'2186	1	489'7814	55'9830	43	43	3'7593	803'3405.
44	'0127	574'2313	2	545'7687	'9873	43	43	'7550	807'0955
44	'0083	578'2396	3	601'7604	'9917	44	41	'7509	810'8464
43	4'0040	582'2436	4	657'7564	55'9960	43	42	'7466	814'5930
43	3'9997	586'2433	5	713'7567	56'0003	43	42	'7424	818'3354
45	'9952	590'2385	6	769'7615	'0048	45	42	'7382	822'0736
43	'9909	594'2294	7	825'7706	'0091	43	43	'7339	825'8075
43	'9866	598'2160	8	881'7840	'0134	43	41	'7298	829'5373
44	'9822	602'1982	9	937'8018	'0178	44	43	'7255	833'2628
43	'9779				'0221	43	42	'7213	
43	'9736	606'1761	10	56993'8239	'0264	43	42	'7171	836'9841
44	'9692	610'1497	1	57049'8503	'0308	44	42	'7129	840'7012
44	'9648	614'1189	2	105'8811	'0352	44	42	'7087	844'4141
42	'9606	618'0837	3	161'9163	'0394	42	42	'7045	848'1228
44	'9562	622'0443	4	217'9557	'0438	44	42	'7003	851'8273
43	'9519	626'0005	15	273'9995	'0481	43	42	'6961	855'5276
44	'9475	629'9524	6	330'0476	'0525	44	42	'6919	859'2237
43	'9432	633'8999	7	386'1001	'0568	43	42	'6877	862'9156
43	'9389	637'8431	8	442'1569	'0611	43	42	'6835	866'6033
43	'9346	641'7820	9	498'2180	'0654	43	41	'6794	870'2868
44	'9302	645'7166	20	551'2834	'0698	44	43	'6751	873'9662
42	'9260	649'6468	1	610'3532	'0740	42	41	'6710	877'6413
44	'9216	653'5728	2	666'4272	'0784	44	42	'6668	881'3123
43	'9173	657'4944	3	722'5056	'0827	43	42	'6626	884'9791
43	'9130	661'4117	4	778'5883	'0870	43	42	'6584	888'6417
43	'9087	665'3247	25	834'6753	'0913	43	42	'6542	892'3001
43	'9044	669'2334	6	890'7666	'0956	43	41	'6501	895'9543
43	'9001	673'1378	7	57946'8622	'0999	43	42	'6459	899'6044
44	'8957	677'0379	8	58002'9621	'1043	44	42	'6417	903'2503
42	'8915	680'9336	9	059'0664	'1085	42	41	'6376	906'8920
43	'8872	684'8251	30	115'1749	'1128	43	42	'6334	910'5296
43	'8829	688'7123	1	171'2877	'1171	43	41	'6293	914'1630
43	'8786	692'5952	2	227'4048	'1214	43	42	'6251	917'7923
43	'8743	696'4738	3	283'5262	'1257	43	42	'6209	921'4174
43	'8700	700'3481	4	339'6519	'1300	43	42	'6167	925'0383
43	'8657	704'2181	35	395'7819	'1343	43	41	'6126	928'6550
42	'8615	708'0838	6	451'9162	'1385	42	41	'6085	932'2676
44	'8571	711'9453	7	508'0547	'1429	44	42	'6043	935'8761
42	'8529	715'8024	8	564'1976	'1471	42	41	'6002	939'4804
43	'8486	719'6553	9	620'3447	'1514	43	41	'5961	943'0806
43	'8443	723'5039	40	676'4961	'1557	43	42	'5919	946'6767
42	'8401	727'3482	1	732'6518	'1599	42	42	'5877	950'2686
43	'8358	731'1883	2	788'8117	'1642	43	41	'5836	953'8563
43	'8315	735'0241	3	844'9759	'1685	43	42	'5795	957'4399
43	'8272	738'8556	4	901'1444	'1728	43	41	'5753	961'0194
42	'8230	742'6828	45	58957'3172	'1770	42	41	'5712	964'5947
42	'8188	746'5058	6	59013'4942	'1812	42	41	'5671	968'1659
44	'8144	750'3246	7	069'6754	'1856	44	41	'5630	971'7330
42	'8102	754'1390	8	125'8610	'1898	42	42	'5588	975'2960
42	'8060	757'9492	9	182'0508	'1940	42	41	'5547	978'8548
43	'8017	761'7552	50	238'2448	'1983	43	41	'5506	982'4095
43	'7974	765'5599	1	294'4431	'2026	43	41	'5465	985'9601
42	'7932	769'3543	2	350'6457	'2068	42	41	'5424	989'5066
42	'7890	773'1475	3	406'8255	'2110	42	42	'5382	993'0490
43	'7847	776'9305	4	463'0635	'2153	43	41	'5341	159996'5872
42	'7805	780'7212	55	519'2788	'2195	42	40	'5301	160000'1213
43	'7762	784'5017	6	575'4983	'2238	43	42	'5259	003'6514
42	'7720	788'2779	7	631'7221	'2280	42	41	'5218	007'1773
42	'7678	792'0499	8	687'9501	'2322	42	41	'5177	010'6991
43	3'7635	795'8177	9	744'1823	'2365	43	40	'5137	014'2168
		159799'5812	60	59800'4188				3'5137	160017'7305.

	-61° .	Diff.	Δ° .	Δ° .	Diff.	62° .		-62° .	Diff.	Δ° .
00	59800 " 4188	"	42	42	"	160017 " 7305.	0	63182 " 2695	"	42
01	856 " 6595	56 " 2407	43	41	3 " 5095	021 " 2400	1	238 " 7600	56 " 4905	41
02	912 " 9045	2450	41	40	5054	024 " 7454	2	295 " 2546	4946	40
03	59969 " 1536	2491	43	42	5014	028 " 2468	3	351 " 7532	4986	42
04	60025 " 4070	2534	42	40	4972	031 " 7440	4	408 " 2560	5028	40
05	081 " 6646	2576	42	42	4932	035 " 2372	5	464 " 7628	5068	42
06	137 " 9264	2618	43	40	4890	038 " 7262	6	521 " 2738	5110	40
07	194 " 1925	2661	41	41	4850	042 " 2112	7	577 " 7888	5150	41
08	250 " 4627	2702	43	40	4809	045 " 6921	8	634 " 3079	5191	40
09	306 " 7372	2745	42	42	4769	049 " 1690	9	690 " 8310	5231	42
		2787			4727				5273	
10	363 " 0159	2829	42	40	4687	052 " 6417	10	747 " 3583		40
11	419 " 2988	2871	42	41	4646	056 " 1104	1	803 " 8896	5313	41
12	475 " 5859	2913	42	41	4605	059 " 5750.	2	860 " 4250	5354	41
13	531 " 8772	2955	42	40	4565	063 " 0355	3	916 " 9645.	5395	40
14	588 " 1727	2997	42	41	4524	066 " 4920	4	63973 " 5080	5435	41
15	644 " 4724	3039	42	41	4483	069 " 9444	15	64030 " 0556	5476	41
16	700 " 7763	3081	42	40	4443	073 " 3927	6	086 " 6073	5517	40
17	757 " 0844	3123	42	41	4402	076 " 8370	7	143 " 1630	5557	41
18	813 " 3967	3165	42	40	4362	080 " 2772	8	199 " 7228	5598	40
19	869 " 7132	3206	41	41	4321	083 " 7134	9	256 " 2866	5638	41
									5679	
20	926 " 0338	3249	43	40	4281	087 " 1455	20	312 " 8545.		40
21	60982 " 3587	3290	41	41	4240	090 " 5736	1	369 " 4264	5719	41
22	61038 " 6877	3332	42	41	4199	093 " 9976	2	426 " 0024	5760	41
23	095 " 0209	3374	42	40	4159	097 " 4175	3	482 " 5825.	5801	40
24	151 " 3583	3416	42	40	4119	100 " 8334	4	539 " 1666	5841	40
25	207 " 6999	3458	42	40	4079	104 " 2453	25	595 " 7547	5881	40
26	264 " 0457	3499	41	41	4038	107 " 6532	6	652 " 3468	5921	41
27	320 " 3956	3541	42	41	3997	111 " 0570	7	708 " 9430	5962	41
28	376 " 7497	3583	42	40	3957	114 " 4567	8	765 " 5433	6003	41
29	433 " 1080	3624	41	40	3917	117 " 8524	9	822 " 1476	6043	40
									6083	
30	489 " 4704	3666	42	40	3877	121 " 2441	30	878 " 7559		40
31	545 " 8370	3707	41	41	3836	124 " 6318	1	935 " 3682	6123	41
32	602 " 2077	3749	42	40	3796	128 " 0154	2	64991 " 9846	6164	41
33	658 " 5826	3791	42	40	3756	131 " 3950	3	65048 " 6050.	6204	40
34	714 " 9617	3833	42	40	3716	134 " 7706	4	105 " 2294	6244	40
35	771 " 3450.	3874	41	41	3675	138 " 1422	35	161 " 8578	6284	41
36	827 " 7324	3915	41	39	3636	141 " 5097	6	218 " 4903	6325	39
37	884 " 1239	3957	42	41	3595	144 " 8733	7	275 " 1267	6364	41
38	940 " 5196	3998	41	40	3555	148 " 2328	8	331 " 7672	6405	40
39	61996 " 9194	4039	41	40	3515	151 " 5883	9	388 " 4117	6445	40
									6485	
40	62053 " 3233	4081	42	40	3475	154 " 9398	40	445 " 0602		40
41	109 " 7314	4123	42	41	3434	158 " 2873	1	501 " 7127	6525	41
42	166 " 1437	4164	41	39	3395	161 " 6307	2	558 " 3693	6566	39
43	222 " 5601	4205	42	40	3355	164 " 9702	3	615 " 0298	6605	40
44	278 " 9806	4247	42	40	3315	168 " 3057	4	671 " 6943	6645	40
45	335 " 4053	4288	41	40	3275	171 " 6372	45	728 " 3628	6685	40
46	391 " 8341	4329	41	40	3235	174 " 9647	6	785 " 0353	6725	40
47	448 " 2670	4370	41	40	3195	178 " 2882	7	841 " 7118	6765	40
48	504 " 7040	4412	42	40	3155	181 " 6077	8	898 " 3923	6805	40
49	561 " 1452	4453	41	40	3115	184 " 9232	9	65955 " 0768	6845	40
									6885	
50	617 " 5905.	4494	41	39	3076	188 " 2347	50	66011 " 7653		39
51	674 " 0399	4535	41	41	3035	191 " 5423	1	068 " 4577	6924	41
52	730 " 4934	4576	41	39	2996	194 " 8458	2	125 " 1542	6965	39
53	786 " 9510	4618	42	40	2956	198 " 1454	3	181 " 8546	7004	40
54	843 " 4128	4659	41	40	2916	201 " 4410	4	238 " 5590	7044	40
55	899 " 8787	4699	40	39	2877	204 " 7326	55	295 " 2674	7084	39
56	62956 " 3486	4741	42	40	2837	208 " 0203	6	351 " 9797	7123	40
57	63012 " 8227	4782	41	40	2797	211 " 3040	7	408 " 6960	7163	40
58	069 " 3009	4823	41	39	2758	214 " 5837	8	465 " 4163	7203	39
59	125 " 7832	4863	40	41	2717	217 " 8595.	9	522 " 1405	7242	41
60	63182 " 2695				3 " 2717	160221 " 1312	60	66578 " 8688	56 " 7283	

Δ°.	Diff.	63°.		-63°.	Diff.	Δ°.	Δ°.	Diff.	64°.
"	"	"	"	"	"	"	"	"	"
39	3'2678	160221'1312	0	66578'8688	56'7322	39	38	3'0343	160410'2698
39	'2639	224'3990	1	635'6010	'7361	39	39	'0304	413'3041
40	'2599	227'6629	2	692'3371	'7401	40	37	'0267	416'3345
39	'2560	230'9228	3	749'0772	'7440	39	39	'0228	419'3612
40	'2520	234'1788	4	805'8212	'7480	40	38	'0190	422'3840
40	'2480	237'4308	5	862'5692	'7520	40	39	'0151	425'4030
39	'2441	240'6788	6	919'3212	'7559	39	39	'0114	428'4181
39	'2402	243'9229	7	66976'0771	'7598	39	37	'0075	431'4295
40	'2362	247'1631	8	67032'8369	'7638	40	37	3'0038	434'4370
39	'2323	250'3993	9	089'6007	'7677	39	39	2'9999	437'4408
40	'2283	253'6316	10	146'3684	'7717	40	37	'9962	440'4407
39	'2244	256'8599	1	203'1401	'7756	39	39	'9923	443'4369
40	'2204	260'0843	2	259'9157	'7796	40	38	'9885	446'4292
38	'2166	263'3047	3	316'6953	'7834	38	37	'9848	449'4177
40	'2126	266'5213	4	373'4787	'7874	40	39	'9809	452'4025
40	'2086	269'7339	15	430'2661	'7914	40	37	'9772	455'3834
38	'2048	272'9425	6	487'0575	'7952	38	38	'9734	458'3606
40	'2008	276'1473	7	543'8527	'7992	40	39	'9695	461'3340
39	'1969	279'3481	8	600'6519	'8031	39	37	'9658	464'3035
39	'1930	282'5450	9	657'4550	'8070	39	38	'9620	467'2693
40	'1890	285'7380	20	714'2620	'8110	40	37	'9583	470'2313
38	'1852	288'9270	1	771'0730	'8148	38	39	'9544	473'1896
40	'1812	292'1122	2	827'8878	'8188	40	37	'9507	476'1410
38	'1774	295'2934	3	884'7066	'8226	38	38	'9469	479'0947
40	'1734	298'4708	4	941'5292	'8266	40	37	'9432	482'0416
39	'1695	301'6442	25	67998'3558	'8305	39	39	'9393	484'9848
39	'1656	304'8137	6	68055'1863	'8344	39	37	'9356	487'9241
39	'1617	307'9793	7	112'0207	'8383	39	37	'9319	490'8597
39	'1578	311'1410	8	168'8590	'8422	39	38	'9281	493'7916
39	'1539	314'2988	9	225'7012	'8461	39	38	'9243	496'7197
39	'1500	317'4527	30	282'5473	'8500	39	38	'9205	499'6410
38	'1462	320'6027	1	339'3973	'8538	38	37	'9168	502'5645
40	'1422	323'7489	2	396'2511	'8578	40	37	'9131	505'4813
38	'1384	326'8911	3	453'1089	'8616	38	38	'9093	508'3944
39	'1345	330'0295	4	509'9705	'8655	39	37	'9056	511'3037
40	'1305	333'1640	35	566'8360	'8695	40	38	'9018	514'2093
38	'1267	336'2945	6	623'7055	'8733	38	37	'8981	517'1111
38	'1229	339'4212	7	680'5788	'8771	38	38	'8943	520'0092
40	'1189	342'5441	8	737'4559	'8811	40	37	'8906	522'9035
38	'1151	345'6630	9	794'3370	'8849	38	38	'8868	525'7944
39	'1112	348'7781	40	851'2219	'8888	39	36	'8832	528'6809
38	'1074	351'8893	1	908'1107	'8926	38	38	'8794	531'5641
40	'1034	354'9967	2	68965'0033	'8966	40	38	'8756	534'4435
38	'0996	358'1001	3	69021'8999	'9004	38	37	'8719	537'3191
38	'0958	361'1997	4	078'8003	'9042	38	37	'8682	540'1910
39	'0919	364'2955	45	135'7045	'9081	39	37	'8645	543'0592
39	'0880	367'3874	6	192'6126	'9120	39	37	'8608	545'9237
38	'0842	370'4754	7	249'5246	'9158	38	38	'8570	548'7845
39	'0803	373'5596	8	306'4404	'9197	39	36	'8534	551'6415
38	'0765	376'6399	9	363'3601	'9235	38	38	'8496	554'4949
39	'0726	379'7164	50	420'2836	'9274	39	37	'8459	557'3445
38	'0688	382'7890	1	477'2110	'9312	38	37	'8422	560'1904
39	'0649	385'8578	2	534'1422	'9351	39	37	'8385	563'0326
38	'0611	388'9227	3	591'0773	'9389	38	37	'8348	565'8711
38	'0573	391'9838	4	648'0162	'9427	38	37	'8311	568'7059
39	'0534	395'0411	55	704'9589	'9466	39	38	'8273	571'5370
38	'0496	398'0945	6	761'9055	'9504	38	36	'8237	574'3643
39	'0457	401'1441	7	818'8559	'9543	39	37	'8200	577'1880
38	'0419	404'1898	8	875'8102	'9581	38	37	'8163	580'0080
38	3'0381	407'2317	9	932'7683	56'9619	38	37	2'8126	582'8243
		160410'2698	60	69989'7302					160585'6369

	-64°.	Diff.	Δ°.	Δ°.	Diff.	65°.		-65°.	Diff.	Δ°.
		"			"				"	
0	69989.7302		38	36	2.8090	160585.6369	0	73414.13631		36
1	70046.6959	56.9657	39	38	'8052	588.4459	1	471.5541	57.1910	38
2	103.6655.	'9696	37	36	'8016	591.2511	2	528.7489	'1948	36
3	160.6388	'9733	39	38	'7978	594.0527	3	585.9473	'1984	38
4	217.6160	'9772	38	36	'7942	596.8505	4	643.1495.	'2022	36
5	274.5970	'9810	39	37	'7905	599.6447	5	700.3553	'2058	37
6	331.5819	'9849	37	36	'7869	602.4352	6	757.5648	'2095	36
7	388.5705	'9886	39	38	'7831	605.2221	7	814.7729	'2131	38
8	445.5630	'9925	37	36	'7795	608.0052	8	871.9948	'2169	36
9	502.5592	56.9962	39	36	'7759	610.7847	9	929.2153	'2205	36
		57.0001							'2241	
10	559.5593	'0038	37	37	'7722	613.5606	10	73986.4394	'2278	37
1	616.5631	'0077	39	37	'7685	616.3328	1	74043.6672	'2315	37
2	673.5708	'0115	38	37	'7648	619.1013	2	100.8987	'2352	37
3	730.5823	'0152	37	36	'7612	621.8661	3	158.1339	'2388	36
4	787.5975	'0191	39	37	'7575	624.6273	4	215.3727	'2425	37
5	844.6166	'0228	38	36	'7539	627.3848	5	272.6152	'2461	36
6	901.6394	'0266	37	37	'7502	630.1387	6	329.8613	'2498	37
7	70958.6660	'0305	39	36	'7466	632.8889	7	387.1111	'2534	36
8	71015.6965.	'0342	37	37	'7429	635.6355	8	444.3645.	'2571	37
9	072.7397	'0380	38	36	'7393	638.3784	9	501.6216	'2607	36
20	129.7687	'0417	37	36	'7357	641.1177	20	558.8823	'2643	36
1	186.8104	'0456	39	37	'7320	643.8534	1	616.1466	'2680	37
2	243.8560	'0493	37	37	'7283	646.5854	2	673.4146	'2717	37
3	300.9053	'0531	38	35	'7248	649.3137	3	730.6863	'2752	35
4	357.9584	'0568	37	37	'7211	652.0385.	4	787.9615	'2789	37
5	415.0152	'0607	39	37	'7174	654.7596	5	845.2404	'2826	36
6	472.0759	'0644	37	35	'7139	657.4770	6	902.5230	'2861	35
7	529.1403	'0681	37	37	'7102	660.1909	7	74959.8091	'2898	37
8	586.2084	'0719	38	36	'7066	662.9011	8	75017.0989	'2934	36
9	643.2803	'0757	38	36	'7030	665.6077	9	074.3923	'2970	36
30	700.3560	'0795	38	37	'6993	668.3107	30	131.6893	'3007	37
1	757.4355.	'0832	37	35	'6958	671.0100	1	188.9900	'3042	35
2	814.5187	'0869	37	37	'6921	673.7058	2	246.2942	'3079	37
3	871.6056	'0907	38	36	'6885	676.3979	3	303.6021	'3115	36
4	928.6963	'0944	37	36	'6849	679.0864	4	360.9136	'3151	36
5	71985.7907	'0982	38	36	'6813	681.7713	5	418.2287	'3187	36
6	72042.8889	'1019	37	36	'6777	684.4526	6	475.5474	'3223	37
7	099.9908	'1057	38	36	'6741	687.1303	7	532.8697	'3259	36
8	157.0965	'1094	37	36	'6705	689.8044	8	590.1956	'3295	36
9	214.2059	'1132	38	37	'6668	692.4749	9	647.5251	'3332	37
40	271.3191	'1168	36	35	'6633	695.1417	40	704.8583	'3367	35
1	328.4359	'1206	38	36	'6597	697.8050	1	762.1950.	'3403	36
2	385.5565	'1244	37	36	'6561	700.4647	2	819.5353	'3439	36
3	442.6809	'1281	37	36	'6525	703.1208	3	876.8792	'3475	36
4	499.8090	'1318	37	35	'6490	705.7733	4	934.2267	'3510	35
5	556.9408	'1355	37	37	'6453	708.4223	5	75991.5777	'3547	37
6	614.0763	'1392	38	35	'6418	711.0676	6	76048.9324	'3582	35
7	671.2155	'1430	36	36	'6382	713.7094	7	106.2906	'3618	36
8	728.3585	'1466	36	36	'6346	716.3476	8	163.6524	'3654	36
9	785.5051	'1504	38	36	'6310	718.9822	9	221.0178	'3690	36
50	842.6555	'1541	37	35	'6275	721.6132	50	278.3868	'3725	35
1	899.8096	'1578	37	36	'6239	724.2407	1	335.7593	'3761	36
2	72956.9674	'1615	37	36	'6203	726.8646	2	393.1354	'3797	36
3	73014.1289	'1652	37	36	'6167	729.4849	3	450.5151	'3833	36
4	071.2941	'1689	37	35	'6132	732.1016	4	507.8984	'3868	35
5	128.4630	'1727	38	35	'6097	734.7148	5	565.2852	'3903	35
6	185.6357	'1763	36	36	'6061	737.3245.	6	622.6755	'3939	36
7	242.8120	'1800	37	36	'6025	739.9306	7	680.0694	'3975	36
8	299.9920	'1837	37	36	'5989	742.5331	8	737.4669	'4011	36
9	357.1757	57.1874	37	35	'5954	745.1320	9	794.8680	'4046	35
60	73414.3631					160747.7274	60	76852.2726		

Δ^2 .	Diff.	66°.		-66°.	Diff.	Δ^2 .	Δ^2 .	Diff.	67°.
35	"	160747'7274	0	76852'2726	"	35	35	"	160897'0403
36	2'5919	750'3193	1	909'6807	57'4081	35	35	2'3831	899'4234
35	'5883	752'9076	2	76967'0924	'4117	35	35	'3798	901'8032
35	'5848	755'4924	3	77024'5076	'4152	35	35	'3763	904'1795
36	'5812	758'0736	4	081'9264	'4188	36	34	'3729	906'5524
35	'5777	760'6513	5	139'3487	'4223	35	34	'3695	908'9219
35	'5742	763'2255	6	196'7745	'4258	35	33	'3662	911'2881
36	'5706	765'7961	7	254'2039	'4294	36	35	'3627	913'6508
35	'5671	768'3632	8	311'6368	'4329	35	33	'3594	916'0102
36	'5635	770'9267	9	369'0733	'4365	36	35	'3559	918'3661
35	'5600				'4400		33	'3526	
35	'5565	773'4867	10	426'5133	'4435	35	34	'3492	920'7187
35	'5530	776'0432	1	483'9568	'4470	35	34	'3458	923'0679
36	'5494	778'5962	2	541'4038	'4506	36	34	'3424	925'4137
34	'5460	781'1456	3	598'8544	'4540	34	34	'3390	927'7561
36	'5424	783'6916	4	656'3084	'4576	36	33	'3357	930'0951
35	'5389	786'2340	15	713'7660	'4611	35	34	'3323	932'4308
35	'5354	788'7729	6	771'2271	'4646	35	34	'3289	934'7631
36	'5318	791'3083	7	828'6917	'4682	36	34	'3255	937'0920
34	'5284	793'8401	8	886'1599	'4716	34	33	'3222	939'4175
35	'5249	796'3685	9	77943'6315	'4751	35	34	'3188	941'7397
36	'5213	798'8934	20	78001'1066	'4787	36	33	'3155	944'0585
34	'5179	801'4147	1	058'5853	'4821	34	35	'3120	946'3740
36	'5143	803'9326	2	116'0674	'4857	36	32	'3088	948'6860
34	'5109	806'4469	3	173'5531	'4891	34	35	'3053	950'9948
35	'5074	808'9578	4	231'0422	'4926	35	33	'3020	953'3001
35	'5039	811'4652	25	288'5348	'4961	35	33	'2987	955'6021
35	'5004	813'9691	6	346'0309	'4996	35	34	'2953	957'9008
35	'4969	816'4695	7	403'5305	'5031	35	33	'2920	960'1961
35	'4934	818'9664	8	461'0336	'5066	35	34	'2886	962'4881
35	'4899	821'4598	9	518'5402	'5101	35	33	'2853	964'7767
34	'4865	823'9497	30	576'0503	'5135	34	33	'2820	967'0620
35	'4830	826'4362	1	633'5638	'5170	35	34	'2786	969'3440
35	'4795	828'9192	2	691'0808	'5205	35	34	'2752	971'6226
35	'4760	831'3987	3	748'6013	'5240	35	32	'2720	973'8978
34	'4726	833'8747	4	806'1253	'5274	34	34	'2686	976'1698
35	'4691	836'3473	35	863'6527	'5309	35	33	'2653	978'4384
35	'4656	838'8164	6	921'1836	'5344	35	33	'2619	980'7037
35	'4621	841'2820	7	78978'7180	'5379	35	33	'2586	982'9656
34	'4587	843'7441	8	79036'2559	'5413	34	32	'2554	985'2242
34	'4553	846'2028	9	093'7972	'5447	34	34	'2520	987'4796
35	'4518	848'6581	40	151'3419	'5482	35	34	'2486	989'7316
35	'4483	851'1099	1	208'8901	'5517	35	32	'2454	991'9802
34	'4449	853'5582	2	266'4418	'5551	34	33	'2421	994'2256
35	'4414	856'0031	3	323'9969	'5586	35	34	'2387	996'4677
34	'4380	858'4445	4	381'5555	'5620	34	33	'2354	160998'7061
34	'4346	860'8825	45	439'1175	'5654	34	32	'2322	161000'9418
35	'4311	863'3171	6	496'6829	'5689	35	34	'2288	003'1740
35	'4276	865'7482	7	554'2518	'5724	35	33	'2255	005'4028
34	'4242	868'1758	8	611'8242	'5758	34	32	'2223	007'6283
34	'4208	870'6000	9	669'4000	'5792	34	34	'2189	009'8506
34	'4174	873'0208	50	726'9792	'5826	34	32	'2157	012'0695
35	'4139	875'4382	1	784'5618	'5861	35	34	'2123	014'2852
34	'4105	877'8521	2	842'1479	'5895	34	33	'2091	016'4975
34	'4071	880'2626	3	899'7374	'5929	34	32	'2058	018'7066
35	'4036	882'6697	4	79957'3393	'5964	35	33	'2025	020'9124
34	'4002	885'0733	55	80014'9267	'5998	34	33	'1992	023'1149
34	'3968	887'4735	6	072'5265	'6032	34	33	'1959	025'3141
34	'3934	889'8703	7	130'1297	'6066	34	32	'1927	027'5100
34	'3900	892'2637	8	187'7363	'6100	34	33	'1894	029'7027
34	2'3866	894'6537	9	245'3463	57'6134	34	33	2'1861	031'8921
		160897'0403	60	80302'9597					161034'0782

-67°.	Diff.	Δ ² .	Δ ¹ .	Diff.	68°.	,	-68°.	Diff.	Δ ² .
80302 " 9597	"		32	"	161034 " 0782	0	83765 " 9218	"	
360 " 5766	57 " 6169	35	34	2 " 1829	036 " 2611	1	823 " 7389	57 " 8171	32
418 " 1968	" 6202	33	32	" 1795	038 " 4406	2	881 " 5594	" 8205	34
475 " 8205	" 6237	35	32	" 1763	040 " 6169	3	939 " 3831	" 8237	32
533 " 4476	" 6271	34	33	" 1731	042 " 7900	4	83997 " 2100	" 8269	32
591 " 0781	" 6305	34	33	" 1698	044 " 9598	5	84055 " 0402	" 8302	33
648 " 7119	" 6338	35	32	" 1665	047 " 1263	6	112 " 8737	" 8335	32
706 " 3492	" 6373	35	32	" 1633	049 " 2896	7	170 " 7104	" 8367	32
763 " 9898	" 6406	33	33	" 1601	051 " 4497	8	228 " 5503	" 8399	32
821 " 6339	" 6441	35	33	" 1568	053 " 6065	9	286 " 3935	" 8432	33
	" 6474	33	33	" 1535				" 8465	33
879 " 2813	" 6508	34	32	" 1503	055 " 7600	10	344 " 2400	" 8497	32
936 " 9321	" 6542	34	33	" 1470	057 " 9103	1	402 " 0897	" 8530	33
80994 " 5863	" 6576	34	32	" 1438	060 " 0573	2	459 " 9427	" 8562	32
81052 " 2439	" 6610	34	32	" 1406	062 " 2011	3	517 " 7989	" 8594	32
109 " 9049	" 6643	33	33	" 1373	064 " 3417	4	575 " 6583	" 8627	33
167 " 5692	" 6677	34	32	" 1341	066 " 4790	15	633 " 5210	" 8659	32
225 " 2369	" 6711	34	32	" 1309	068 " 6131	6	691 " 3869	" 8691	32
282 " 9080	" 6745	34	33	" 1276	070 " 7440	7	749 " 2560	" 8724	33
340 " 5825	" 6778	33	32	" 1244	072 " 8716	8	807 " 1284	" 8756	32
398 " 2603	" 6812	34	32	" 1212	074 " 9960	9	865 " 0040	" 8788	32
455 " 9415	" 6845	33	32	" 1180	077 " 1172	20	922 " 8828	" 8820	32
513 " 6260	" 6880	35	33	" 1147	079 " 2352	1	84980 " 7648	" 8853	33
571 " 3140	" 6912	32	31	" 1116	081 " 3499	2	85038 " 6501	" 8884	31
629 " 0052	" 6947	35	33	" 1083	083 " 4615	3	096 " 5385	" 8917	33
686 " 6999	" 6980	33	32	" 1051	085 " 5698	4	154 " 4302	" 8949	32
744 " 3979	" 7013	33	33	" 1018	087 " 6749	25	212 " 3251	" 8982	33
802 " 0992	" 7047	34	31	" 0987	089 " 7767	6	270 " 2233	" 9013	31
859 " 8039	" 7080	33	32	" 0955	091 " 8754	7	328 " 1246	" 9045	32
917 " 5119	" 7114	34	32	" 0923	093 " 9709	8	386 " 0291	" 9077	32
81975 " 2233	" 7147	33	33	" 0890	096 " 0632	9	443 " 9368	" 9110	33
82032 " 9380	" 7180	33	31	" 0859	098 " 1522	30	501 " 8478	" 9141	31
090 " 6560	" 7214	34	32	" 0827	100 " 2381	1	559 " 7619	" 9173	32
148 " 3774	" 7248	34	32	" 0795	102 " 3208	2	617 " 6792	" 9205	32
206 " 1022	" 7280	32	32	" 0763	104 " 4003	3	675 " 5997	" 9237	32
263 " 8302	" 7314	34	32	" 0731	106 " 4766	4	733 " 5234	" 9269	32
321 " 5616	" 7347	34	32	" 0699	108 " 5497	35	791 " 4503	" 9301	32
379 " 2963	" 7381	34	32	" 0667	110 " 6196	6	849 " 3804	" 9333	32
437 " 9344	" 7414	33	31	" 0636	112 " 6863	7	907 " 3137	" 9364	31
494 " 7758	" 7446	32	32	" 0604	114 " 7499	8	85965 " 2501	" 9396	32
552 " 5204	" 7480	34	32	" 0572	116 " 8103	9	86023 " 1897	" 9428	32
610 " 2684	" 7514	34	32	" 0540	118 " 8675	40	081 " 1325	" 9460	32
668 " 0198	" 7546	32	32	" 0508	120 " 9215	1	139 " 0785	" 9492	32
725 " 7744	" 7579	33	31	" 0477	122 " 9723	2	197 " 0277	" 9523	31
783 " 5323	" 7613	34	32	" 0445	125 " 0200	3	254 " 9800	" 9555	32
841 " 2936	" 7646	33	31	" 0414	127 " 0645	4	312 " 9355	" 9586	31
899 " 0582	" 7678	32	32	" 0382	129 " 1059	45	370 " 8941	" 9618	32
82956 " 8260	" 7712	34	32	" 0350	131 " 1441	6	428 " 8559	" 9650	32
83014 " 5972	" 7745	33	32	" 0318	133 " 1791	7	486 " 8209	" 9682	32
072 " 3717	" 7777	32	31	" 0287	135 " 2109	8	544 " 7891	" 9713	31
130 " 1494	" 7811	34	31	" 0256	137 " 2396	9	602 " 7604	" 9744	31
187 " 9305	" 7843	32	32	" 0224	139 " 2652	50	660 " 7348	" 9776	32
245 " 7148	" 7877	34	31	" 0193	141 " 2876	1	718 " 7124	" 9807	31
303 " 5025	" 7909	33	32	" 0161	143 " 3069	2	776 " 6931	" 9839	32
361 " 2934	" 7942	33	32	" 0129	145 " 3230	3	834 " 6770	" 9871	32
419 " 0876	" 7975	33	30	" 0099	147 " 3359	4	892 " 6641	" 9901	30
476 " 8851	" 8008	33	32	" 0067	149 " 3458	55	86950 " 6542	" 9933	32
534 " 6859	" 8041	33	32	" 0035	151 " 3525	6	87008 " 6475	" 9965	32
592 " 4900	" 8073	32	31	" 0004	153 " 3560	7	066 " 6440	57 " 9996	31
650 " 2973	" 8106	33	31	1 " 9973	155 " 3564	8	124 " 6436	58 " 0027	31
708 " 1079	57 " 8139	33	32	1 " 9941	157 " 3537	9	182 " 6463	58 " 0059	32
83765 " 9218					161159 " 3478	60	87240 " 6522		

Δ°.	Diff.	69°.		-69°.	Diff.	Δ°.	Δ°.	Diff.	70°.
"	"	"		"	"	"	"	"	"
30	I'9911	161159'3478	0	87240'6522	58'0089	30	30	I'8077	161273'35
32	'9879	161'3389	1	298'6611	'0121	32	29	'8048	275'16
32	'9847	163'3268	2	356'6732	'0153	32	31	'8017	276'92
30	'9817	165'3115	3	414'6885	'0183	30	29	'7988	278'57
32	'9785	167'2932	4	472'7068	'0215	32	30	'7958	280'57
31	'9754	169'2717	5	530'7283	'0246	31	29	'7929	282'36
30	'9724	171'2471	6	588'7529	'0276	30	30	'7899	284'16
32	'9692	173'2195	7	646'7805	'0308	32	30	'7869	285'9
31	'9661	175'1887	8	704'8113	'0339	31	30	'7839	287'72
32	'9629	177'1548	9	762'8452	'0371	32	29	'7810	289'52
30	'9599	179'1177	10	820'8823	'0401	30	30	'7780	291'30
31	'9568	181'0776	1	878'9224	'0432	31	30	'7750	293'08
31	'9537	183'0344	2	936'9656	'0463	31	29	'7721	294'85
31	'9506	184'9881	3	879955'0119	'0494	31	29	'7692	296'62
31	'9475	186'9387	4	88053'0613	'0525	31	30	'7662	298'30
31	'9444	188'8862	15	111'1138	'0556	31	30	'7632	300'16
31	'9413	190'8306	6	169'1694	'0587	31	29	'7603	301'92
31	'9382	192'7719	7	227'2281	'0618	31	29	'7574	303'68
31	'9351	194'7101	8	285'2899	'0649	31	30	'7544	305'4
31	'9320	196'6452	9	343'3548	'0680	31	29	'7515	307'19
30	'9290	198'5772	20	401'4228	'0710	30	30	'7485	308'95
31	'9259	200'5062	1	459'4938	'0741	31	29	'7456	310'60
30	'9229	202'4321	2	517'5679	'0771	30	29	'7427	312'42
32	'9197	204'3550	3	575'6450	'0803	32	30	'7397	314'18
30	'9167	206'2747	4	633'7253	'0833	30	29	'7368	315'92
31	'9136	208'1914	25	691'8086	'0864	31	29	'7339	317'60
30	'9106	210'1050	6	749'8950	'0894	30	29	'7310	319'39
32	'9074	212'0156	7	807'9844	'0926	32	30	'7280	321'12
29	'9045	213'9230	8	866'0770	'0955	29	29	'7251	322'80
32	'9013	215'8275	9	924'1725	'0987	32	28	'7223	324'58
30	'8983	217'7288	30	88982'2712	'1017	30	30	'7193	326'30
30	'8953	219'6271	1	89040'3729	'1047	30	29	'7164	328'02
31	'8922	221'5224	2	098'4776	'1078	31	30	'7134	329'72
31	'8891	223'4146	3	156'5854	'1109	31	28	'7106	331'45
30	'8861	225'3037	4	214'6963	'1139	30	29	'7077	333'16
30	'8831	227'1898	35	272'8102	'1169	30	29	'7048	334'82
31	'8800	229'0729	6	330'9271	'1200	31	30	'7018	336'52
30	'8770	230'9529	7	389'0471	'1230	30	28	'7018	338'27
30	'8740	232'8299	8	447'1701	'1260	30	29	'6990	339'92
31	'8709	234'7039	9	505'2961	'1291	31	29	'6961	341'62
31	'8678	236'5748	40	563'4252	'1322	31	29	'6932	343'36
29	'8649	238'4426	1	621'5574	'1351	29	29	'6903	345'05
31	'8618	240'3075	2	679'6925	'1382	31	29	'6874	346'70
30	'8588	242'1693	3	737'8307	'1412	30	28	'6845	348'42
30	'8558	244'0281	4	795'9719	'1442	30	28	'6817	350'17
31	'8527	245'8839	45	854'1161	'1473	31	28	'6787	351'78
30	'8497	247'7366	6	912'2634	'1503	30	29	'6759	353'46
29	'8468	249'5863	7	89970'4137	'1532	29	28	'6730	355'13
31	'8437	251'4331	8	90028'5669	'1563	31	29	'6702	356'80
31	'8406	253'2768	9	086'7232	'1594	31	29	'6673	358'42
29	'8377	255'1174	50	144'8826	'1623	29	29	'6644	360'15
30	'8347	256'9551	1	203'0449	'1653	30	28	'6615	361'80
30	'8317	258'7898	2	261'2102	'1683	30	29	'6587	363'45
30	'8287	260'6215	3	319'3785	'1713	30	28	'6558	365'11
31	'8256	262'4502	4	377'5498	'1744	31	29	'6530	366'76
29	'8227	264'2758	55	435'7242	'1773	29	29	'6501	368'41
30	'8197	266'0985	6	493'9015	'1803	30	28	'6472	370'06
30	'8167	267'9182	7	552'0818	'1833	30	28	'6444	371'71
30	'8137	269'7349	8	610'2651	'1863	30	29	'6416	373'33
30	I'8107	271'5486	9	668'4514	58'1893	30	28	'6387	374'99
		161273'3593	60	90726'6407				I'6359	161376'62

-70° .	Diff.	Δ° .	Δ' .	Diff.	71° .		-71° .	Diff.	Δ° .
90726 6407	"	"	"	"	161376 6262	0	94223 3738	"	"
784 8330	58 1923	30	29	1 6330	378 2592	1	281 7408	58 3670	29
843 0282	1952	29	29	6301	379 8893	2	340 1107	3699	29
901 2265	1983	31	27	6274	381 5167	3	398 4833	3726	27
90959 4277	2012	29	29	6245	383 1412	4	456 8588	3755	29
91017 6319	2042	30	28	6217	384 7629	5	515 2371	3783	28
075 8390	2071	29	29	6188	386 3817	6	573 6183	3812	29
134 0491	2101	30	27	6161	387 9978	7	632 0022	3839	27
192 2622	2131	30	29	6132	389 6110	8	690 3890	3868	29
250 4783	2161	30	28	6104	391 2214	9	748 7786	3896	28
	2190	29	29	6075				3925	29
308 6973	2220	30	27	6048	392 8289	10	807 1711	3952	27
366 9193	2250	30	29	6019	394 4337	1	865 5663	3981	29
425 1443	2279	29	28	5991	396 0356	2	923 9644	4009	28
483 3722	2308	29	28	5963	397 6347	3	94982 3653	4037	28
541 6030	2338	30	28	5935	399 2310	4	95040 7690	4065	28
599 8368	2368	30	28	5907	400 8245	15	099 1755	4093	28
658 0736	2397	29	28	5879	402 4152	6	157 5848	4121	28
716 3133	2426	29	28	5851	404 0031	7	215 9969	4149	28
774 5559	2456	30	28	5823	405 5882	8	274 4118	4177	28
832 8015	2485	29	28	5795	407 1705	9	332 8295	4205	28
891 0500	2515	30	28	5767	408 7500	20	391 2500	4233	28
91949 3015	2544	29	28	5739	410 3267	1	449 6733	4261	28
92007 5559	2573	29	28	5711	411 9006	2	508 0994	4289	28
065 8132	2603	30	27	5684	413 4717	3	566 5283	4316	29
124 0735	2632	29	29	5655	415 0401	4	624 9599	4345	27
182 3367	2661	29	27	5628	416 6056	25	683 3944	4372	27
240 6028	2690	29	28	5600	418 1684	6	741 8316	4400	28
298 8718	2720	30	28	5572	419 7284	7	800 2716	4428	28
357 1438	2749	29	27	5545	421 2856	8	858 7144	4455	27
415 4187	2777	28	29	5516	422 8401	9	917 1599	4484	29
473 6964	2807	30	27	5489	424 3917	30	95975 6083	4511	27
531 9771	2836	29	27	5462	425 9406	1	96034 0594	4538	27
590 2607	2866	30	28	5434	427 4868	2	092 5132	4566	28
648 5473	2894	28	28	5406	429 0302	3	150 9698	4594	28
706 8367	2923	29	28	5378	430 5708	4	209 4292	4622	28
765 1290	2952	29	27	5351	432 1086	35	267 8914	4649	27
823 4242	2982	30	27	5324	433 6437	6	326 3563	4676	27
881 7224	3010	28	28	5296	435 1761	7	384 8239	4704	28
940 0234	3039	29	28	5268	436 7057	8	443 2943	4732	28
92998 3273	3068	29	27	5241	438 2325	9	501 7675	4759	27
93056 6341	3097	29	27	5214	439 7566	40	560 2434	4786	27
114 9438	3126	29	28	5186	441 2780	1	618 7220	4814	28
173 2564	3155	29	28	5158	442 7966	2	677 2034	4842	28
231 5719	3183	28	27	5131	444 3124	3	735 6876	4869	27
289 8902	3213	30	27	5104	445 8255	4	794 1745	4896	27
348 2115	3241	28	27	5077	447 3359	45	852 6641	4923	28
406 5356	3270	29	28	5049	448 8436	6	911 1564	4951	27
464 8626	3298	28	27	5022	450 3485	7	96969 6515	4978	27
523 1924	3327	29	27	4995	451 8507	8	97028 1493	5005	27
581 5251	3356	29	27	4968	453 3502	9	086 6498	5032	27
639 8607	3385	29	28	4940	454 8470	50	145 1530	5060	28
698 1992	3413	28	27	4913	456 3410	1	203 6590	5087	27
756 5405	3442	29	27	4886	457 8323	2	262 1677	5114	27
814 8847	3470	28	27	4859	459 3209	3	320 6791	5141	27
873 2317	3499	29	27	4832	460 8068	4	379 1932	5168	27
931 5816	3528	29	28	4804	462 2900	55	437 7100	5196	28
93989 9344	3556	28	26	4778	463 7704	6	496 2296	5222	26
94048 2900	3584	28	26	4750	465 2482	7	554 7518	5250	28
106 6484	3613	29	26	4724	466 7232	8	613 2768	5276	28
165 0097	3641	28	28	4696	468 1956	9	671 8044	5304	28
94223 3738					161469 6652	60	97730 3348		

Δ^2 .	Diff.	72° .		-72° .	Diff.	Δ^2 .	Δ^2 .	Diff.	73° .
26	"	161469	0	97730	"	26	25	"	161552
27	1'4670	471'1322	1	788'8678	58'5330	26	26	1'3096	554'30
28	'4643	472'5965	2	847'4035	'5357	27	26	'3070	555'6
26	'4615	474'0580	3	905'9420	'5385	26	25	'3045	556'9
27	'4589	475'5169	4	97964'4831	'5411	27	26	'3020	558'21
27	'4562	476'9731	5	98023'0269	'5438	27	26	'2994	559'5
27	'4535	478'4266	6	081'5734	'5465	27	25	'2968	560'8
26	'4508	479'8774	7	140'1226	'5492	26	25	'2943	562'1
27	'4482	481'3256	8	198'6744	'5518	27	25	'2918	563'40
27	'4455	482'7711	9	257'2289	'5545	27	26	'2893	564'69
	'4428				'5572			'2867	
27	'4401	484'2139	10	315'7861	'5599	27	25	'2842	565'92
27	'4374	485'6540	1	374'3460	'5626	27	25	'2817	567'20
26	'4348	487'0914	2	432'9086	'5652	26	25	'2792	568'5
27	'4321	488'5262	3	491'4738	'5679	27	26	'2766	569'82
26	'4295	489'9583	4	550'0417	'5705	26	25	'2741	571'00
27	'4268	491'3878	15	608'6122	'5732	27	25	'2716	572'37
27	'4241	492'8146	6	667'1854	'5759	27	25	'2691	573'6
26	'4215	494'2387	7	725'7613	'5785	26	25	'2666	574'9
27	'4188	495'6602	8	784'3398	'5812	27	26	'2640	576'18
26	'4162	497'0790	9	842'9210	'5838	26	24	'2616	577'4
27	'4135	498'4952	20	901'5048	'5865	27	25	'2591	578'70
26	'4109	499'9087	1	98960'0913	'5891	26	26	'2565	579'96
26	'4083	501'3196	2	99018'6804	'5917	26	24	'2541	581'22
27	'4056	502'7279	3	077'2721	'5944	27	25	'2516	582'47
27	'4029	504'1335	4	135'8665	'5971	27	25	'2491	583'72
26	'4003	505'5364	25	194'4636	'5997	26	26	'2465	584'97
26	'3977	506'9367	6	253'0633	'6023	26	24	'2441	586'22
26	'3951	508'3344	7	311'6656	'6049	26	24	'2417	587'46
27	'3924	509'7295	8	370'2705	'6076	27	26	'2391	588'70
26	'3898	511'1219	9	428'8781	'6102	26	25	'2366	589'94
26	'3872	512'5117	30	487'4883	'6128	26	24	'2342	591'18
27	'3846	513'8989	1	546'1011	'6154	26	25	'2317	592'41
27	'3819	515'2835	2	604'7165	'6181	27	25	'2292	593'65
26	'3793	516'6654	3	663'3346	'6207	26	24	'2268	594'88
26	'3767	518'0447	4	721'9553	'6233	26	26	'2242	596'10
26	'3741	519'4214	35	780'5786	'6259	26	24	'2218	597'33
26	'3715	520'7955	6	839'2045	'6285	26	24	'2194	598'55
26	'3689	522'1670	7	897'8330	'6311	26	25	'2169	599'77
26	'3663	523'5359	8	99956'4641	'6337	26	25	'2144	600'98
27	'3636	524'9022	9	100015'0978	'6364	27	24	'2120	602'20
25	'3611	526'2658	40	073'7342	'6389	25	25	'2095	603'41
26	'3585	527'6269	1	132'3731	'6415	26	24	'2071	604'62
26	'3559	528'9854	2	191'0146	'6441	26	25	'2046	605'83
26	'3533	530'3413	3	249'6587	'6467	26	24	'2022	607'03
26	'3507	531'6946	4	308'3054	'6493	26	25	'1997	608'23
26	'3481	533'0453	45	366'9547	'6519	26	24	'1973	609'43
26	'3455	534'3934	6	425'6066	'6545	26	25	'1948	610'63
26	'3429	535'7389	7	484'2611	'6571	26	24	'1924	611'83
25	'3404	537'0818	8	542'9182	'6596	25	24	'1900	613'02
26	'3378	538'4222	9	601'5778	'6622	26	25	'1875	614'21
26	'3352	539'7600	50	660'2400	'6648	26	24	'1851	615'40
25	'3326	541'0952	1	718'9048	'6674	26	24	'1827	616'58
26	'3301	542'4278	2	777'5722	'6699	25	24	'1803	617'70
26	'3275	543'7579	3	836'2421	'6725	26	25	'1778	618'9
26	'3249	545'0854	4	894'9146	'6751	26	24	'1754	620'12
24	'3223	546'4103	55	100953'5897	'6777	26	24	'1730	621'30
27	'3199	547'7326	6	101012'2674	'6801	27	24	'1706	622'47
25	'3172	549'0525	7	070'9475	'6828	25	24	'1682	623'64
25	'3147	550'3697	8	129'6303	'6853	25	25	'1657	624'81
26	1'3121	551'6844	9	188'3156	'6879	26	23	1'1634	625'97
	161552	9965	60	101247'0035					161627'14

-73°.	Diff.	Δ°.	Δ°.	Diff.	74°.	-74°.	Diff.	Δ°.
101247°0035.	"	"	"	"	161627°1429	0	104772°8571	"
305°6939	58°6904	25	25	1°1609	628°3038	1	831°6962	58°8391
364°3869	'6930	26	23	'1586	629°4624	2	890°5376	'8414
423°0824	'6955	25	25	'1561	630°6185	3	104949°3815.	'8439
481°7804	'6980	26	25	'1538	631°7723	4	105008°2277	'8462
540°4810	'7006	26	23	'1513	632°9236	5	067°0764	'8487
599°1842	'7032	25	25	'1490	634°0726	6	125°9274	'8510
657°8899	'7057	25	23	'1465	635°2191	7	184°7809	'8535
716°5981	'7082	25	24	'1442	636°3633	8	243°6367	'8558
775°3088	'7107	26	24	'1418	637°5051	9	302°4949	'8582
	'7133			'1394				'8606
834°0221	'7158	25	23	'1371	638°6445.	10	361°3555	'8629
892°7379	'7183	25	25	'1346	639°7816	1	420°2184	'8654
101951°4562	'7208	25	23	'1323	640°9162	2	479°0838	'8677
102010°1770	'7234	26	24	'1299	642°0485.	3	537°9515	'8701
068°9004	'7259	25	24	'1275	643°1784	4	596°8216	'8725
127°6263	'7284	25	23	'1252	644°3059	15	655°6941	'8748
186°3547	'7309	25	24	'1228	645°4311	6	714°5689	'8772
245°0856	'7334	26	24	'1204	646°5539	7	773°4461	'8796
303°8190	'7360	24	23	'1181	647°6743	8	832°3257	'8819
362°5550.	'7384		24	'1157	648°7924	9	891°2076	'8843
421°2934	'7409	25	24	'1133	649°9081	20	105950°0919	'8867
480°0343	'7435	26	23	'1110	651°0214	1	106008°0786	'8890
538°7778	'7459	24	23	'1087	652°1324	2	067°8676	'8913
597°5237	'7484	25	25	'1062	653°2411	3	126°7589	'8938
656°2721	'7509	26	22	'1040	654°3473	4	185°6527	'8960
715°0230	'7535	26	24	'1016	655°4513	25	244°5487	'8984
773°7765.	'7559	24	23	'0993	656°5529	6	303°4471	'9007
832°5324	'7583	26	24	'0969	657°6522	7	362°3478	'9031
891°2907	'7609	25	23	'0946	658°7491	8	421°2509	'9054
102950°0516	'7634		24	'0922	659°8437	9	480°1563	'9078
103008°8150.	'7658	24	23	'0899	660°9359	30	539°0641	'9101
067°5808	'7683	25	23	'0876	662°0258	1	597°9742	'9124
126°3491	'7708	25	23	'0853	663°1134	2	656°8866	'9147
185°1199	'7732	26	23	'0830	664°1987	3	715°8013	'9170
243°8931	'7758	24	24	'0806	665°2817	4	774°7183	'9194
302°6689	'7782	24	23	'0783	666°3623	35	833°6377	'9217
361°4471	'7806	25	24	'0759	667°4406	6	892°5594	'9241
420°2277	'7831	25	22	'0737	668°5165	7	106951°4835.	'9263
479°0108	'7856	25	23	'0714	669°5902	8	107010°4098	'9286
537°7964	'7880	24	24	'0690	670°6616	9	069°3384	'9310
596°5844	'7905	25	23	'0667	671°7306	40	128°2694	'9333
655°3749	'7929	25	22	'0645	672°7973	1	187°2027	'9355
714°1678	'7954	24	24	'0621	673°8618	2	246°1382	'9379
772°9632	'7978	24	23	'0598	674°9239	3	305°0761	'9402
831°7610	'8003	25	23	'0575	675°9837	4	364°0163	'9425
890°5613	'8027	24	22	'0553	677°0412	45	422°9588	'9447
103949°3640	'8052	24	24	'0529	678°0965.	6	481°9035	'9471
104008°1692	'8076	24	22	'0507	679°1494	7	540°8506	'9493
066°9768	'8100	25	24	'0483	680°2001	8	599°7999	'9517
125°7868	'8125		22	'0461	681°2484	9	658°7516	'9539
184°5993	'8149	24	23	'0438	682°2945	50	717°7055.	'9562
243°4142	'8173	24	23	'0415	683°3383	1	776°6617	'9585
302°2315.	'8197	25	23	'0392	684°3798	2	835°6202	'9608
361°0512	'8222	25	22	'0370	685°4190	3	894°5810	'9630
419°8734	'8246	24	23	'0347	686°4560	4	107953°5440	'9653
478°6980	'8270	24	23	'0324	687°4907	55	108012°5093	'9676
537°5250.	'8294	24	23	'0301	688°5231	6	071°4769	'9699
596°3544	'8318	25	22	'0279	689°5532	7	130°4468	'9721
655°1862	'8343	23	23	'0256	690°5811	8	189°4189	'9744
714°0205.	58°8366		22	'0234	691°6067	9	248°3933	'9766
104772°8571					161692°6301	60	108307°3699	

Δ°.	Diff.	75°.		-75°.	Diff.	Δ°.	Δ°.	Diff.	76°.
23	"	161692'630I	0	108307'3699	"	23	22	"	161749'98I
23	1'0211	693'6512	1	366'3488	58'9789	23	20	0'8900	750'87I
23	'0188	694'6700	2	425'3300	'9812	23	21	'8880	751'76I
22	'0166	695'6866	3	484'3134	'9834	22	21	'8859	752'65I
23	'0143	696'7009	4	543'2991	'9857	23	22	'8837	753'53I
22	'0121	697'7130	5	602'2870	'9879	22	20	'8817	754'41I
22	'0099	698'7229	6	661'2771	'9901	22	22	'8795	755'29I
23	'0076	699'7305	7	720'2695	'9924	23	22	'8775	756'17I
23	'0053	700'7358	8	779'2642	'9947	22	20	'8753	757'04I
22	'0031	701'7389	9	838'2611	'9969	22	21	'8733	757'92I
22	1'0009				58'9991	22		'8712	
22	0'9987	702'7398	10	897'2602		22	21	'8691	758'79I
23	'9964	703'7385	1	108956'2615	59'0013	23	21	'8670	759'66I
22	'9942	704'7349	2	109015'2651	'0036	22	21	'8649	760'52I
23	'9919	705'7291	3	074'2709	'0058	23	20	'8629	761'39I
21	'9898	706'7210	4	133'2790	'0081	21	21	'8608	762'25I
23	'9875	707'7108	15	192'2892	'0102	21	21	'8587	763'11I
22	'9853	708'6983	6	251'3017	'0125	22	21	'8566	763'97I
23	'9830	709'6836	7	310'3164	'0147	23	20	'8546	764'83I
21	'9809	710'6666	8	369'3334	'0170	21	21	'8525	765'68I
23	'9786	711'6475	9	428'3525	'0191	23	21	'8504	766'53I
					'0214				
21	'9765	712'6261	20	487'3739	'0235	21	21	'8483	767'39I
23	'9742	713'6026	1	546'3974	'0258	23	20	'8463	768'23I
22	'9720	714'5768	2	605'4232	'0280	22	20	'8443	769'08I
21	'9699	715'5488	3	664'4512	'0301	21	21	'8422	769'92I
23	'9676	716'5187	4	723'4813	'0324	23	21	'8401	770'77I
22	'9654	717'4863	25	782'5137	'0346	22	20	'8381	771'61I
21	'9633	718'4517	6	841'5483	'0367	21	20	'8361	772'44I
23	'9610	719'4150	7	900'5850	'0390	23	21	'8340	773'28I
22	'9588	720'3760	8	109959'6240	'0412	22	20	'8320	774'11I
21	'9567	721'3348	9	110018'6652	'0433	21	21	'8299	774'95I
22	'9545	722'2915	30	077'7085	'0455	22	20	'8279	775'78I
22	'9523	723'2460	1	136'7540	'0477	22	21	'8258	776'60I
22	'9501	724'1983	2	195'8017	'0499	22	20	'8238	777'43I
21	'9479	725'1484	3	254'8516	'0521	21	20	'8218	778'25I
22	'9458	726'0963	4	313'9037	'0542	22	21	'8198	779'08I
22	'9436	727'0421	35	372'9579	'0564	22	21	'8177	779'90I
21	'9414	727'9857	6	432'0143	'0586	21	20	'8157	780'71I
22	'9393	728'9271	7	491'0729	'0607	22	20	'8137	781'53I
22	'9371	729'8664	8	550'1336	'0629	22	20	'8117	782'34I
22	'9349	730'8035	9	609'1965	'0651	22	21	'8096	783'15I
22	'9327	731'7384	40	668'2616	'0673	22	19	'8077	783'96I
21	'9306	732'6711	1	727'3289	'0694	21	21	'8056	784'77I
21	'9285	733'6017	2	786'3983	'0715	21	19	'8037	785'58I
22	'9263	734'5302	3	845'4698	'0737	22	21	'8016	786'38I
22	'9241	735'4565	4	904'5435	'0759	22	20	'7996	787'18I
21	'9220	736'3806	45	110963'6194	'0780	21	20	'7976	787'98I
21	'9199	737'3026	6	111022'6974	'0801	21	19	'7957	788'78I
22	'9177	738'2225	7	081'7775	'0823	22	21	'7936	789'58I
21	'9156	739'1402	8	140'8598	'0844	21	20	'7916	790'37I
22	'9134	740'0558	9	199'9442	'0866	22	19	'7897	791'16I
21	'9113	740'9692	50	259'0308	'0887	21	21	'7876	791'95I
21	'9092	741'8805	1	318'1195	'0908	21	19	'7857	792'74I
22	'9070	742'7897	2	377'2103	'0930	22	20	'7837	793'52I
21	'9049	743'6967	3	436'3033	'0951	21	20	'7817	794'31I
21	'9028	744'6016	4	495'3984	'0972	21	20	'7797	795'09I
22	'9006	745'5044	55	554'4956	'0994	22	19	'7778	795'87I
20	'8986	746'4050	6	613'5950	'1014	20	20	'7758	796'65I
22	'8964	747'3036	7	672'6964	'1036	22	20	'7738	797'42I
21	'8943	748'2000	8	731'8000	'1057	21	20	'7718	798'20I
21	0'8922	749'0943	9	790'9057	59'1078	21	19	0'7699	798'97I
		161749'9865	60	111850'0135					161799'74

-76° .	Diff.	Δ° .	Δ° .	Diff.	77° .	Δ° .	-77° .	Diff.	Δ° .
111850.0135	"	"	"	"	161799.7428	0	115400.2572	"	"
909.1235	59.1100	22	20	0.7679	800.5107	1	459.4893	59.2321	19
111968.2355	.1120	21	20	.7660	801.2767	2	518.7233	.2340	20
112027.3496	.1141	22	20	.7640	802.0407	3	577.9593	.2360	20
086.4659	.1163	20	19	.7620	802.8027	4	637.1973	.2380	19
145.5842	.1183	22	19	.7601	803.5628	5	696.4372	.2399	19
204.7047	.1205	20	20	.7582	804.3210	6	755.6790	.2418	20
263.8272	.1225	22	20	.7562	805.0772	7	814.9228	.2438	20
322.9519	.1247	20	19	.7542	805.8314	8	874.1686	.2458	19
382.0786	.1267	21	19	.7523	806.5837	9	933.4163	.2477	19
	.1288			.7504				.2496	
441.2074		21	20		807.3341	10	115992.6659	.2516	20
500.3383	.1309	21	19	.7484	808.0825	1	116051.9175	.2535	19
559.4713	.1330	21	20	.7465	808.8290	2	111.1710	.2555	20
618.6064	.1351	20	19	.7445	809.5735	3	170.4265	.2574	19
677.7435	.1371	21	19	.7426	810.3161	4	229.6839	.2593	19
736.8827	.1392	21	19	.7407	811.0568	15	288.9432	.2612	19
796.0240	.1413	21	19	.7388	811.7956	6	348.2044	.2631	19
855.1674	.1434	20	20	.7369	812.5325	7	407.4675	.2651	20
914.3128	.1454	21	19	.7349	813.2674	8	466.7326	.2670	19
112973.4603	.1475	21	19	.7330	814.0004	9	525.9996	.2689	19
	.1496			.7311					
113032.6099		21	19		814.7315	20	585.2685	.2708	19
091.7616	.1517	20	20	.7292	815.4607	1	644.5393	.2728	20
150.9153	.1537	20	18	.7272	816.1879	2	703.8121	.2746	18
210.0710	.1557	21	20	.7254	816.9133	3	763.0867	.2766	20
269.2288	.1578	21	19	.7234	817.6367	4	822.3633	.2785	19
328.3887	.1599	20	18	.7215	818.3582	25	881.6418	.2803	18
387.5506	.1619	20	20	.7197	819.0779	6	116940.9221	.2823	20
446.7145	.1639	21	18	.7177	819.7956	7	117000.2044	.2841	18
505.8805	.1660	20	20	.7159	820.5115	8	059.4885	.2861	20
565.0485	.1680	21	18	.7139	821.2254	9	118.7746	.2879	18
	.1701			.7121					
624.2186	.1721	20	19	.7102	821.9375	30	178.0625	.2898	19
683.3907	.1742	21	19	.7083	822.6477	1	237.3523	.2917	19
742.5649	.1762	20	19	.7064	823.3560	2	296.6440	.2936	19
801.7411	.1782	20	19	.7045	824.0624	3	355.9376	.2955	19
860.9193	.1802	20	18	.7027	824.7669	4	415.2331	.2973	18
920.0995	.1823	21	20	.7007	825.4696	35	474.5304	.2993	20
113979.2818	.1843	20	18	.6989	826.1703	6	533.8297	.3011	18
114038.4661	.1863	20	19	.6970	826.8692	7	593.1308	.3030	19
097.6524	.1883	20	18	.6952	827.5662	8	652.4338	.3048	18
156.8407	.1904	21	19	.6933	828.2614	9	711.7386	.3067	19
216.0311	.1923	19	19	.6914	828.9547	40	771.0453	.3086	19
275.2234	.1944	21	18	.6896	829.6461	1	830.3539	.3104	18
334.4178	.1963	19	19	.6877	830.3357	2	889.6643	.3123	19
393.6141	.1984	21	19	.6858	831.0234	3	117948.9766	.3142	19
452.8125	.2004	20	18	.6840	831.7092	4	118008.2908	.3160	18
512.0129	.2024	20	18	.6822	832.3932	45	067.6668	.3178	18
571.2153	.2043	19	19	.6803	833.0754	6	126.9216	.3197	19
630.4196	.2064	21	19	.6784	833.7557	7	186.2443	.3216	19
689.6260	.2084	20	18	.6766	834.4341	8	245.5659	.3234	18
748.8344	.2103	19	18	.6748	835.1107	9	304.8893	.3252	18
808.0447	.2124	21	19	.6729	835.7855	50	364.2145	.3271	19
867.2571	.2143	19	18	.6711	836.4584	1	423.5416	.3289	18
926.4714	.2163	20	19	.6692	837.1295	2	482.8705	.3308	19
114985.6877	.2183	20	18	.6674	837.7987	3	542.2013	.3326	18
115044.9060	.2203	20	18	.6656	838.4661	4	601.5339	.3344	18
104.1263	.2222	19	18	.6638	839.1317	55	660.8683	.3362	19
163.3485	.2242	20	19	.6619	839.7955	6	720.2045	.3381	19
222.5727	.2262	20	18	.6601	840.4574	7	779.5426	.3399	18
281.7989	.2282	20	18	.6583	841.1175	8	838.8825	.3417	18
341.0271	.2301	19	18	.6565	841.7758	9	898.2242	.3435	18
115400.2572	59.2301			0.6565	161842.4323	60	118957.5677		

Δ^2 .	Diff.	78° .		-78° .	Diff.	Δ^2 .	Δ^2 .	Diff.	79° .
18	"	161842	"	118957	"	18	16	"	161878
19	0'6547	843'0870	1	119016	3453	19	17	0'5504	879'14
17	'6528	843'7398	2	076'2602	3472	17	17	'5487	879'68
19	'6511	844'3909	3	135'6091	3489	19	16	'5470	880'23
18	'6492	845'0401	4	194'9599	3508	18	17	'5454	880'78
17	'6474	845'6875	5	254'3125	3526	17	16	'5437	881'32
19	'6457	846'3332	6	313'6668	3543	19	17	'5421	881'86
18	'6438	846'9770	7	373'0230	3562	18	17	'5404	882'40
17	'6420	847'6190	8	432'3810	3580	17	16	'5387	882'94
19	'6403	848'2593	9	491'7407	3597	19	16	'5371	883'48
	'6384				3616			'5355	
17	'6367	848'8977	10	551'1023	3633	17	16	'5339	884'01
18	'6349	849'5344	1	610'4656	3651	18	17	'5322	884'55
19	'6330	850'1693	2	669'8307	3670	19	17	'5305	885'08
17	'6313	850'8023	3	729'1977	3687	17	15	'5290	885'61
19	'6296	851'4336	4	788'5664	3704	19	17	'5273	886'14
17	'6277	852'0632	15	847'9368	3723	17	17	'5256	886'67
19	'6260	852'6909	6	907'3091	3740	19	15	'5241	887'19
18	'6242	853'3169	7	119966'6831	3758	18	17	'5224	887'72
17	'6224	853'9411	8	120026'0589	3776	17	16	'5208	888'24
19	'6207	854'5635	9	085'4365	3793	19	16	'5192	888'76
18	'6189	855'1842	20	144'8158	3811	18	16	'5176	889'28
17	'6171	855'8031	1	204'1969	3829	17	16	'5160	889'80
19	'6154	856'4202	2	263'5798	3846	19	17	'5143	890'31
18	'6136	857'0356	3	322'9644	3864	18	16	'5127	890'83
17	'6119	857'6492	4	382'3508	3881	17	15	'5112	891'34
19	'6101	858'2611	25	441'7389	3899	19	17	'5095	891'85
18	'6084	858'8712	6	501'1288	3916	18	15	'5080	892'36
17	'6066	859'4796	7	560'5204	3934	17	17	'5063	892'87
19	'6049	860'0862	8	619'9138	3951	19	16	'5047	893'37
18	'6031	860'6911	9	679'3089	3969	18	15	'5032	893'88
17	'6014	861'2942	30	738'7058	3986	17	17	'5015	894'38
19	'5996	861'8956	1	798'1044	4004	19	15	'5000	894'88
18	'5979	862'4952	2	857'5048	4021	18	16	'4984	895'38
17	'5962	863'0931	3	916'9069	4038	17	16	'4968	895'88
19	'5945	863'6893	4	120976'3107	4055	19	16	'4952	896'38
18	'5927	864'2838	35	121035'7162	4073	18	15	'4937	896'87
17	'5910	864'8765	6	095'1235	4090	17	17	'4920	897'37
19	'5893	865'4675	7	154'5325	4107	19	17	'4905	897'86
18	'5876	866'0568	8	213'9432	4124	18	15	'4890	898'35
17	'5858	866'6444	9	273'3556	4142	17	17	'4873	898'84
19	'5841	867'2302	40	332'7698	4159	19	15	'4858	899'33
18	'5824	867'8143	1	392'1857	4176	18	16	'4842	899'81
17	'5807	868'3967	2	451'6033	4193	17	15	'4827	900'30
19	'5790	868'9774	3	511'0226	4210	19	16	'4811	900'78
18	'5773	869'5564	4	570'4436	4227	18	15	'4796	901'26
17	'5756	870'1337	45	629'8663	4244	17	16	'4780	901'74
19	'5739	870'7093	6	689'2907	4261	19	16	'4764	902'22
18	'5722	871'2832	7	748'7168	4278	18	15	'4749	902'69
17	'5705	871'8554	8	808'1446	4295	17	15	'4734	903'17
19	'5688	872'4259	9	867'5741	4312	19	16	'4718	903'64
18	'5671	872'9947	50	927'0053	4329	18	16	'4702	904'12
17	'5655	873'5618	1	121986'4382	4345	17	14	'4688	904'59
19	'5637	874'1273	2	122045'8727	4363	19	16	'4672	905'05
18	'5621	874'6910	3	105'3090	4379	18	15	'4657	905'52
17	'5603	875'2531	4	164'7469	4397	17	16	'4641	905'99
19	'5588	875'8134	55	224'1866	4412	19	15	'4626	906'45
18	'5570	876'3722	6	283'6278	4430	18	15	'4611	906'91
17	'5553	876'9292	7	343'0708	4447	17	15	'4596	907'37
19	'5537	877'4845	8	402'5155	4463	19	16	'4580	907'83
18	'5520	878'0382	9	461'9618	4480	18	14	'4566	908'29
	161878	3902	60	122521'4098	59'4480			161908	75

	-79°.	Diff.	Δ°.	Δ°.	Diff.	80°.		-80°.	Diff.	Δ°.
0	122521.4098		16	16		161908.7539	0	126091.2461		16
1	580.8594	59.4496	17	15	0.4550	909.2089	1	150.7911	59.5450	15
2	640.3107	.4513	17	15	.4535	909.6624	2	210.3376	.5465	15
3	699.7637	.4530	16	16	.4520	910.1144	3	269.8856	.5480	16
4	759.2183	.4546	17	14	.4504	910.5648	4	329.4352	.5496	14
5	818.6746	.4563	16	15	.4490	911.0138	5	388.9862	.5510	15
6	878.1325	.4579	17	16	.4475	911.4613	6	448.5387	.5525	16
7	937.5921	.4596	17	14	.4459	911.9072	7	508.0928	.5541	14
8	122997.0534	.4613	16	15	.4445	912.3517	8	567.6483	.5555	15
9	123056.5163	.4629	16	15	.4430	912.7947	9	627.2053	.5570	15
		.4645			.4415				.5585	
10	115.9808		16	15		913.2362	10	686.7638	.5600	15
1	175.4469	.4661	17	15	.4400	913.6762	1	746.3238	.5615	15
2	234.9147	.4678	17	15	.4385	914.1147	2	805.8853	.5630	15
3	294.3842	.4695	17	15	.4370	914.5517	3	865.4483	.5645	15
4	353.8552	.4710	17	14	.4355	914.9872	4	925.0128	.5659	14
5	413.3279	.4727	17	15	.4341	915.4213	5	126984.5787	.5674	15
6	472.8023	.4744	15	15	.4326	915.8539	6	127044.1461	.5689	15
7	532.2782	.4759	17	15	.4311	916.2850	7	103.7150	.5704	15
8	591.7558	.4776	16	14	.4296	916.7146	8	163.2854	.5718	14
9	651.2350	.4792	16	15	.4282	917.1428	9	222.8572	.5733	15
		.4808			.4267					
20	710.7158	.4824	16	15	.4252	917.5695	20	282.4305	.5748	15
1	770.1982	.4840	16	15	.4237	917.9947	1	342.0053	.5763	15
2	829.6822	.4857	16	14	.4223	918.4184	2	401.5816	.5777	14
3	889.1679	.4873	15	15	.4209	918.8407	3	461.1593	.5791	15
4	123948.6552	.4888	15	15	.4194	919.2616	4	520.7384	.5806	15
5	124008.1440	.4905	17	15	.4179	919.6810	5	580.3190	.5821	15
6	067.6345	.4920	15	14	.4165	920.0989	6	639.9011	.5835	14
7	127.1265	.4937	17	14	.4151	920.5154	7	699.4846	.5849	14
8	186.6202	.4953	16	15	.4136	920.9305	8	759.0695	.5864	15
9	246.1155	.4968	15	15	.4121	921.3441	9	818.6559	.5879	15
30	305.6123	.4985	17	14	.4107	921.7562	30	878.2438	.5893	14
1	365.1108	.5000	15	14	.4093	922.1669	1	937.8331	.5907	14
2	424.6108	.5016	16	15	.4078	922.5762	2	127997.4238	.5922	15
3	484.1124	.5032	16	14	.4064	922.9840	3	128057.0160	.5936	14
4	543.6156	.5048	16	14	.4050	923.3904	4	116.6066	.5950	14
5	603.1204	.5063	15	14	.4036	923.7954	5	176.2046	.5964	14
6	662.6267	.5080	17	15	.4021	924.1990	6	235.8010	.5979	15
7	722.1347	.5095	15	14	.4007	924.6011	7	295.3989	.5993	14
8	781.6442	.5110	15	14	.3993	925.0018	8	354.9982	.6007	14
9	841.1552	.5127	17	15	.3978	925.4011	9	414.5989	.6022	15
40	900.6679	.5142	15	13	.3965	925.7989	40	474.2011	.6035	13
1	124960.1821	.5158	16	15	.3950	926.1954	1	533.8046	.6050	15
2	125019.6979	.5173	15	14	.3936	926.5904	2	593.4096	.6064	14
3	079.2152	.5189	16	13	.3923	926.9840	3	653.0160	.6077	13
4	138.7341	.5204	15	15	.3908	927.3763	4	712.6237	.6092	15
5	198.2545	.5220	16	14	.3894	927.7671	5	772.2329	.6106	14
6	257.7765	.5236	16	14	.3880	928.1565	6	831.8435	.6120	14
7	317.3001	.5251	15	14	.3866	928.5445	7	891.4555	.6134	14
8	376.8252	.5266	15	14	.3852	928.9311	8	128951.0689	.6148	14
9	436.3518	.5282	16	14	.3838	929.3163	9	129010.6837	.6162	14
50	495.8800	.5298	16	13	.3825	929.7001	50	070.2999	.6175	13
1	555.4098	.5312	14	15	.3810	930.0826	1	129.9174	.6190	15
2	614.9410	.5328	16	13	.3797	930.4636	2	189.5364	.6203	13
3	674.4738	.5343	15	15	.3782	930.8433	3	249.1567	.6218	15
4	734.0081	.5359	16	13	.3769	931.2215	4	308.7785	.6231	13
5	793.5440	.5374	15	13	.3756	931.5984	5	368.4016	.6244	15
6	853.0814	.5389	15	15	.3741	931.9740	6	428.0260	.6259	15
7	912.6203	.5404	15	13	.3728	932.3481	7	487.6519	.6272	13
8	125972.1607	.5420	16	14	.3714	932.7209	8	547.2791	.6286	14
9	126031.7027	.5434	14	14	.3700	933.0923	9	606.9077	.6300	14
60	126091.2461					161933.4623	60	129666.5377		

Δ° .	Diff.	81° .	'	-81° .	Diff.	Δ° .	Δ° .	Diff.	82° .
13	"	"	0	"	"	13	11	"	"
13	0'3687	161933'4623	0	129666'5377	59'6313	13	11	0'2914	161953'2563
14	'3673	933'8310	1	726'1690	'6327	14	13	'2901	'5477
14	'3659	934'1983	2	785'8017	'6341	14	11	'2890	'8378
13	'3646	'5642	3	845'4358	'6354	13	13	'2877	954'1268
14	'3632	'9288	4	905'0712	'6368	14	12	'2865	'4145
13	'3619	935'2920	5	129964'7080	'6381	13	12	'2853	'7010
13	'3606	'6539	6	130024'3461	'6394	13	12	'2841	'9863
15	'3591	936'0145	7	083'9855	'6409	15	11	'2830	955'2704
12	'3579	'3736	8	143'6264	'6421	12	13	'2817	'5534
14	'3565	'7315	9	203'2685	'6435	14	12	'2805	'8351
14	'3551	937'0880	10	262'9120	'6449	14	11	'2794	956'1156
13	'3538	'4431	1	322'5569	'6462	13	13	'2781	'3950
13	'3525	'7969	2	382'2031	'6475	13	11	'2770	'6731
13	'3512	938'1494	3	441'8506	'6488	13	12	'2758	'9501
14	'3498	'5006	4	501'4994	'6502	14	12	'2746	957'2259
13	'3485	'8504	15	561'1496	'6515	13	12	'2734	'5005
14	'3471	939'1989	6	620'8011	'6529	14	11	'2723	'7739
12	'3459	'5460	7	680'4540	'6541	12	12	'2711	958'0462
14	'3445	'8919	8	740'1081	'6555	14	12	'2699	'3173
13	'3432	940'2364	9	799'7636	'6568	13	11	'2688	'5872
13	'3419	'5796	20	859'4204	'6581	13	12	'2676	'8560
13	'3406	'9215	1	919'0785	'6594	13	12	'2664	959'1236
13	'3393	941'2621	2	130978'7379	'6607	13	11	'2653	'3900
14	'3379	'6014	3	131038'3986	'6621	14	12	'2641	'6553
12	'3379	'9393	4	098'0607	'6633	12	12	'2629	'9194
14	'3353	942'2760	25	157'7240	'6647	14	11	'2618	960'1823
12	'3341	'6113	6	217'3887	'6659	12	11	'2607	'4441
14	'3327	'9454	7	277'0546	'6673	14	12	'2595	'7048
12	'3315	943'2781	8	336'7219	'6685	12	12	'2583	'9643
13	'3302	'6096	9	396'3904	'6698	13	10	'2573	961'2226
13	'3289	'9398	30	456'0602	'6711	13	12	'2561	'4799
14	'3275	944'2687	1	515'7313	'6725	14	12	'2549	'7360
12	'3263	'5962	2	575'4038	'6737	12	11	'2538	'9909
12	'3251	'9225	3	635'0775	'6749	12	11	'2527	962'2447
14	'3237	945'2476	4	694'7524	'6763	14	11	'2516	'4974
12	'3225	'5713	35	754'4287	'6775	12	12	'2504	'7490
13	'3212	'8938	6	814'1062	'6788	13	11	'2493	'9994
13	'3199	946'2150	7	873'7850	'6801	13	11	'2482	963'2487
12	'3187	'5349	8	933'4651	'6813	12	12	'2470	'4969
14	'3173	'8536	9	131993'1464	'6827	14	10	'2460	'7439
11	'3162	947'1709	40	132052'8291	'6838	11	12	'2448	'9899
14	'3148	'4871	1	112'5129	'6852	14	11	'2437	964'2347
12	'3136	'8019	2	172'1981	'6864	12	11	'2426	'4784
13	'3123	948'1155	3	231'8845	'6877	13	10	'2416	'7210
12	'3111	'4278	4	291'5722	'6889	12	12	'2404	'9626
12	'3099	'7389	45	351'2611	'6901	12	11	'2393	965'2030
14	'3085	949'0488	6	410'9512	'6915	14	11	'2382	'4423
11	'3074	'3573	7	470'6427	'6926	11	11	'2371	'6805
13	'3061	'6647	8	530'3353	'6939	13	11	'2360	'9176
13	'3048	'9708	9	590'0292	'6952	13	11	'2349	966'1536
12	'3036	950'2756	50	649'7244	'6964	12	11	'2338	'3885
12	'3024	'5792	1	709'4208	'6976	12	10	'2328	'6223
12	'3012	'8816	2	769'1184	'6988	12	12	'2316	'8551
13	'2999	951'1828	3	828'8172	'7001	13	10	'2306	967'0867
13	'2986	'4827	4	888'5173	'7014	13	11	'2295	'3173
11	'2975	'7813	55	132948'2187	'7025	11	10	'2285	'5468
13	'2962	952'0788	6	133007'9212	'7038	13	12	'2273	'7753
12	'2950	'3750	7	067'6250	'7050	12	10	'2263	968'0026
12	'2938	'6700	8	127'3300	'7062	12	11	'2252	'2289
13	0'2925	'9638	9	187'0362	'7075	13	10	0'2242	'4541
		161953'2563	60	133246'7437					161968'6783

	-82°.	Diff.	Δ°.	Δ°.	Diff.	83°.		-83°.	Diff.	Δ°.
0	133246 ⁷ 7437	"	"	"	"	161968 ⁶ 783	0	136831 ³ 3217	"	"
1	306 ⁴ 4523	59 ⁷ 086	11	12	0 ² 230	'9013	1	891 ⁰ 987	59 ⁷ 770	12
2	366 ¹ 1622	'7099	13	9	'2221	969 ¹ 234	2	136950 ⁸ 766	'7779	9
3	425 ⁸ 732	'7110	11	12	'2209	'3443	3	137010 ⁶ 557	'7791	12
4	485 ⁵ 5855	'7123	13	10	'2199	'5642	4	070 ⁴ 4358	'7801	10
5	545 ² 990	'7135	12	10	'2189	'7831	5	130 ² 2169	'7811	11
6	605 ⁰ 137	'7147	12	11	'2178	970 ⁰ 009	6	189 ⁰ 9991	'7822	11
7	664 ⁷ 296	'7159	11	9	'2167	'2176	7	249 ⁷ 7824	'7833	9
8	724 ⁴ 466	'7170	13	12	'2158	'4334	8	309 ⁵ 5666	'7842	12
9	784 ¹ 1649	'7183	10	10	'2146	'6480	9	369 ³ 3520	'7854	10
		'7195			'2136				'7864	
0	843 ⁸ 844	'7206	11	10	'2126	'8616	10	429 ¹ 1384	'7874	10
1	903 ⁶ 6050	'7219	13	10	'2116	971 ⁰ 742	1	488 ⁸ 9258	'7884	10
2	133963 ³ 269	'7230	11	11	'2105	'2858	2	548 ⁷ 142	'7895	11
3	134023 ⁰ 499	'7242	12	10	'2095	'4963	3	608 ⁶ 5037	'7905	10
4	082 ⁰ 7741	'7254	12	10	'2085	'7058	4	668 ² 2942	'7915	11
5	142 ⁴ 4995	'7266	11	11	'2074	'9143	5	728 ⁰ 857	'7926	11
6	202 ² 2261	'7277	11	10	'2064	972 ¹ 217	6	787 ⁸ 8783	'7936	10
7	261 ⁹ 538	'7289	12	10	'2054	'3281	7	847 ⁶ 719	'7946	10
8	321 ⁶ 827	'7301	12	10	'2044	'5335	8	907 ⁴ 665	'7956	10
9	381 ⁴ 128	'7312	11	11	'2033	'7379	9	137967 ² 621	'7967	11
0	441 ¹ 1440	'7324	12	9	'2024	'9412	20	138027 ⁰ 588	'7976	9
1	500 ⁸ 764	'7336	12	11	'2013	973 ¹ 436	1	086 ⁸ 564	'7987	11
2	560 ⁶ 100	'7347	11	10	'2003	'3449	2	146 ⁶ 551	'7997	10
3	620 ³ 447	'7359	12	10	'1993	'5452	3	206 ⁴ 548	'8007	9
4	680 ⁰ 806	'7371	12	9	'1984	'7445	4	266 ² 555	'8016	10
5	739 ⁸ 177	'7382	11	11	'1973	'9429	25	326 ⁰ 571	'8027	11
6	799 ⁵ 559	'7393	11	10	'1963	974 ¹ 402	6	385 ⁸ 598	'8037	10
7	859 ² 952	'7405	12	10	'1953	'3365	7	445 ⁶ 635	'8047	10
8	919 ⁰ 357	'7417	12	10	'1943	'5318	8	505 ⁴ 682	'8057	10
9	134978 ⁷ 774	'7427	10	9	'1934	'7261	9	565 ² 739	'8066	9
0	135038 ⁵ 201	'7439	12	11	'1923	'9195	30	625 ⁰ 805	'8077	11
1	098 ² 640	'7451	12	9	'1914	975 ¹ 118	1	684 ⁸ 882	'8086	9
2	158 ⁰ 091	'7462	11	10	'1904	'3032	2	744 ⁶ 698	'8096	10
3	217 ⁷ 553	'7473	11	10	'1894	'4936	3	804 ⁴ 5064	'8106	10
4	277 ⁵ 026	'7484	11	10	'1884	'6830	4	864 ³ 170	'8116	10
5	337 ² 510	'7496	12	10	'1874	'8714	35	924 ¹ 286	'8126	10
6	397 ⁰ 006	'7507	11	9	'1865	976 ⁰ 588	6	138983 ⁹ 412	'8135	9
7	456 ⁷ 513	'7518	11	10	'1855	'2453	7	139043 ⁷ 547	'8145	10
8	516 ⁵ 031	'7530	12	9	'1846	'4308	8	103 ⁵ 5692	'8154	9
9	576 ² 561	'7540	10	11	'1835	'6154	9	163 ³ 3846	'8165	11
0	636 ⁰ 101	'7552	12	8	'1827	'7989	40	223 ² 011	'8173	8
1	695 ⁷ 653	'7563	11	11	'1816	'9816	1	283 ⁰ 184	'8184	11
2	755 ⁵ 216	'7574	11	9	'1807	977 ¹ 632	2	342 ⁸ 368	'8193	9
3	815 ² 790	'7584	10	10	'1797	'3439	3	402 ⁶ 561	'8203	10
4	875 ⁰ 374	'7596	12	9	'1788	'5236	4	462 ⁴ 764	'8212	9
5	934 ⁷ 970	'7607	11	9	'1779	'7024	45	522 ² 2976	'8221	9
6	135994 ⁵ 577	'7618	11	11	'1768	'8803	6	582 ¹ 197	'8232	8
7	136054 ³ 195	'7629	11	8	'1760	978 ⁰ 571	7	641 ⁹ 429	'8240	11
8	114 ⁰ 824	'7640	11	10	'1750	'2331	8	701 ⁷ 669	'8250	10
9	173 ⁸ 864	'7651	11	9	'1741	'4081	9	761 ⁵ 5919	'8259	9
0	233 ⁶ 115	'7662	11	10	'1731	'5822	50	821 ⁴ 178	'8269	10
1	293 ³ 777	'7672	10	9	'1722	'7553	1	881 ² 2447	'8278	9
2	353 ¹ 449	'7684	12	10	'1712	'9275	2	139941 ⁰ 725	'8288	10
3	412 ⁹ 133	'7694	10	9	'1703	979 ⁰ 987	3	140000 ⁹ 013	'8297	9
4	472 ⁶ 827	'7705	11	9	'1694	'2690	4	060 ⁷ 7310	'8306	9
5	532 ⁴ 532	'7715	10	9	'1685	'4384	55	120 ⁵ 5616	'8315	9
6	592 ² 247	'7727	12	9	'1676	'6069	6	180 ³ 3931	'8324	9
7	651 ⁰ 9974	'7737	10	10	'1666	'7745	7	240 ² 2255	'8334	10
8	711 ⁷ 711	'7748	11	9	'1657	'9411	8	300 ⁰ 589	'8343	9
9	771 ⁵ 459	'7758	10	9	'1648	980 ¹ 068	9	359 ⁸ 932	'8352	9
0	136831 ³ 217					161980 ² 716	60	140419 ⁷ 284		

Δ° .	Diff.	84° .	"	-84° .	Diff.	Δ° .	Δ° .	Diff.	85° .
9	"	"	"	"	"	9	75	"	"
9	0'1639	161980'2716	0	140419'7284	59'8361	9	75	0'11378	161988'58119
9	'1630	'4355	1	479'5645	'8370	9	75	'11303	'69497
10	'1620	'5985	2	539'4015	'8380	10	77	'11226	'80800
8	'1612	'7605	3	599'2395	'8388	8	75	'11151	'92026
9	'1603	'9217	4	659'0783	'8397	9	75	'11076	989'03177
10	'1593	981'0820	5	718'9180	'8407	10	74	'11002	'14253
8	'1585	'2413	6	778'7587	'8415	8	75	'10927	'25255
9	'1576	'3998	7	838'6002	'8424	9	75	'10852	'36182
9	'1567	'5574	8	898'4426	'8433	9	73	'10779	'47034
9	'1558	'7141	9	140958'2859	'8442	9	74	'10705	'57813
9	'1549	'8699	10	141018'1301	'8451	9	74	'10631	'68518
9	'1540	982'0248	1	077'9752	'8460	9	73	'10558	'79149
8	'1531	'1788	2	137'8212	'8469	8	73	'10485	'89707
9	'1523	'3319	3	197'6681	'8477	8	73	'10412	990'00192
9	'1514	'4842	4	257'5158	'8486	9	72	'10340	'10604
9	'1505	'6356	15	317'3644	'8495	9	73	'10267	'20944
9	'1496	'7861	6	377'2139	'8504	9	71	'10196	'31211
8	'1488	'9357	7	437'0643	'8512	8	73	'10123	'41407
9	'1479	983'0845	8	496'9155	'8521	9	71	'10052	'51530
9	'1470	'2324	9	556'7676	'8530	9	71	'09981	'61582
8	'1462	'3794	20	616'6206	'8538	8	71	'09910	'71563
9	'1453	'5256	1	676'4744	'8547	9	71	'09839	'81473
85	'14445	'6709	2	736'3291	'8555	85	70	'09769	'91312
84	'14361	'81535	3	796'18465	'85639	84	71	'09698	991'01081
86	'14275	'95896	4	856'04104	'85725	86	69	'09629	'10779
85	'14190	984'10171	25	915'89829	'85810	85	71	'09558	'20408
84	'14106	'24361	6	141975'75639	'85894	84	68	'09490	'29966
85	'14021	'38467	7	142035'61533	'85979	85	70	'09420	'39456
84	'13937	'52488	8	095'47512	'86063	84	70	'09350	'48876
83	'13854	'66425	9	155'33575	'86146	83	67	'09283	'58226
85	'13769	'80279	30	215'19721	'86231	85	69	'09214	'67509
83	'13686	'94048	1	275'05952	'86314	83	69	'09145	'76723
82	'13604	985'07734	2	334'92266	'86396	82	67	'09078	'85868
84	'13520	'21338	3	394'78662	'86480	84	68	'09010	'94946
83	'13437	'34858	4	454'65142	'86563	83	68	'08942	992'03956
81	'13356	'48295	35	514'51705	'86644	81	67	'08875	'12898
83	'13273	'61651	6	574'38349	'86727	83	66	'08809	'21773
82	'13191	'74924	7	634'25076	'86809	82	66	'08741	'30582
82	'13109	'88115	8	694'11885	'86891	82	65	'08676	'39323
80	'13029	986'01224	9	753'98776	'86971	80	68	'08608	'47999
82	'12947	'14253	40	813'85747	'87053	82	65	'08543	'56607
81	'12866	'27200	1	873'72800	'87134	81	65	'08478	'65150
80	'12786	'40066	2	933'59934	'87214	80	66	'08412	'73628
81	'12705	'52852	3	142993'47148	'87295	81	65	'08347	'82040
80	'12625	'65557	4	143053'34443	'87375	80	65	'08282	'90387
80	'12545	'78182	45	113'21818	'87455	80	65	'08217	'98669
79	'12466	'90727	6	173'09273	'87534	79	65	'08152	993'06886
79	'12387	987'03193	7	232'96807	'87613	79	63	'08089	'15038
80	'12307	'15580	8	292'84420	'87693	80	64	'08025	'23127
79	'12228	'27887	9	352'72113	'87772	79	65	'07960	'31152
78	'12150	'40115	50	412'59885	'87850	78	62	'07898	'39112
78	'12072	'52265	1	472'47735	'87928	78	63	'07835	'47010
79	'11993	'64337	2	532'35663	'88007	79	64	'07771	'54845
77	'11916	'76330	3	592'23670	'88084	77	62	'07709	'62616
78	'11838	'88246	4	652'11754	'88162	78	62	'07647	'70325
78	'11760	988'00084	55	711'99916	'88240	78	63	'07584	'77972
76	'11684	'11844	6	771'88156	'88316	76	62	'07522	'85556
77	'11607	'23528	7	831'76472	'88393	77	61	'07461	'93078
76	'11531	'35135	8	891'64865	'88469	76	61	'07400	994'00539
78	0'11453	'46666	9	143951'53334	59'88547	78	62	0'07338	'07939
		161988'58119	60	144011'41881					161994'15277

	-85°.	Diff.	Δ°.	Δ°.	Diff.	86°.		-86°.	Diff.	Δ°.
0	144011'41881	"		61	"	161994'15277	0	147605'84723	"	61
1	071'30503	59'88622	75	60	0'07277	22554	1	665'77446	59'92723	60
2	131'19200	88697	75	60	0'07217	29771	2	725'70229	92783	60
3	191'07974	88774	75	61	0'07157	36928	3	785'63072	92843	61
4	250'96823	88849	75	59	0'07096	44024	4	845'55976	92904	59
5	310'85747	88924	75	61	0'07037	51061	5	905'48939	92963	61
6	370'74745	88998	74	59	0'06976	58037	6	147965'41963	93024	59
7	430'63818	89073	75	59	0'06917	64954	7	148025'35046	93083	59
8	490'52966	89148	75	57	0'06858	71812	8	085'28188	93142	57
9	550'42187	89221	73	60	0'06801	78613	9	145'21387	93199	60
		89295	74		0'06741				93259	
10	610'31482	89369	74	58	0'06683	85354	10	205'14646	93317	58
1	670'20851	89442	73	59	0'06624	92037	1	265'07963	93376	59
2	730'10293	89515	73	57	0'06567	98661	2	325'01339	93433	57
3	789'98908	89588	73	58	0'06509	995'05228	3	384'94772	93491	58
4	849'89396	89660	72	57	0'06452	11737	4	444'88263	93548	57
5	909'79056	89733	73	57	0'06452	18189	15	504'81811	93548	57
6	144969'68789	89804	71	58	0'06395	24584	6	564'75416	93605	58
7	145029'58593	89877	73	55	0'06337	30921	7	624'69079	93663	55
8	089'48470	89948	71	57	0'06282	37297	8	684'62797	93718	57
9	149'38418	90019	71	56	0'06225	43428	9	744'56572	93775	56
					0'06169				93831	
20	209'28437	90090	71	56	0'06113	49597	20	804'50403	93887	56
1	269'18527	90161	71	55	0'06058	55710	1	864'44290	93942	55
2	329'08688	90231	70	56	0'06002	61768	2	924'38232	93998	56
3	388'98919	90302	71	55	0'05947	67770	3	148984'32230	94053	55
4	448'89221	90371	69	54	0'05893	73717	4	149044'26283	94107	54
5	508'79592	90442	71	55	0'05838	79610	25	104'20390	94162	55
6	568'70034	90514	68	55	0'05783	85448	6	164'14552	94217	55
7	628'60544	90580	70	53	0'05730	91231	7	224'08769	94270	53
8	688'51124	90650	70	54	0'05676	96961	8	284'03039	94324	54
9	748'41774	90717	67	54	0'05622	996'02637	9	343'97363	94378	54
30	808'32491	90786	69	53	0'05569	08259	30	403'91741	94431	53
1	868'23277	90855	69	53	0'05516	13828	1	463'86172	94484	53
2	928'14132	90922	67	53	0'05463	19344	2	523'80656	94537	53
3	145988'05054	90990	68	52	0'05411	24807	3	583'75193	94589	52
4	146047'96044	91058	68	53	0'05358	30218	4	643'69782	94642	53
5	167'87102	91125	67	51	0'05307	35576	35	703'64424	94693	51
6	167'78227	91191	66	53	0'05254	40883	6	763'59117	94746	53
7	227'69418	91259	68	51	0'05203	46137	7	823'53863	94797	51
8	287'60677	91324	65	51	0'05152	51340	8	883'48660	94848	51
9	347'52001	91392	68	51	0'05101	56492	9	149943'43508	94899	51
40	407'43393	91457	65	51	0'05050	61593	40	150003'38407	94950	51
1	467'34850	91522	65	50	0'05000	66643	1	063'33357	95000	50
2	527'26372	91588	66	50	0'04950	71643	2	123'28357	95050	50
3	587'17960	91653	65	51	0'04899	76593	3	183'23407	95101	49
4	647'09613	91718	65	49	0'04850	81492	4	243'18508	95150	51
5	707'01331	91783	65	50	0'04800	86342	45	303'13658	95200	50
6	766'93114	91848	65	49	0'04751	91142	6	363'08858	95249	49
7	826'84962	91911	63	49	0'04702	95893	7	423'04107	95298	49
8	886'76873	91975	64	48	0'04654	997'00595	8	482'99405	95346	48
9	146946'68848	92040	65	49	0'04605	05249	9	542'94751	95395	49
50	147006'60888	92102	62	48	0'04557	09854	50	602'90146	95443	48
1	066'52990	92165	63	49	0'04508	14411	1	662'85589	95492	49
2	126'45155	92229	64	47	0'04461	18919	2	722'81081	95539	47
3	186'37384	92291	62	47	0'04414	23380	3	782'76620	95586	47
4	246'29675	92353	62	48	0'04366	27794	4	842'72206	95634	48
5	306'22028	92416	63	46	0'04320	32160	55	902'67840	95680	46
6	366'14444	92478	62	47	0'04273	36480	6	150962'63520	95727	47
7	426'06922	92539	61	47	0'04226	40753	7	151022'59247	95774	47
8	485'99461	92600	61	46	0'04180	44979	8	082'55021	95820	46
9	545'92061	92662	62	45	0'04135	49159	9	142'50841	95865	45
60	147605'84723					161997'53294	60	151202'46706		

Δ^2	Diff.	87°		-87°	Diff.	Δ^2	Δ^1	Diff.	88°
47	"	161997	"	151202	"	47	30	"	161999
45	0'04088	53294	0	46706	59'95912	45	31	0'01813	26896
45	0'04043	57382	1	262'42618	'95957	45	31	0'1782	28709
45	0'3998	61425	2	322'38575	'96002	45	30	0'1752	30491
44	0'3954	65423	3	382'34577	'96046	44	30	0'1722	32243
46	0'3908	69377	4	442'30623	'96092	46	29	0'1693	33965
44	0'3864	73285	5	502'26715	'96136	44	29	0'1664	35655
44	0'3820	77149	6	562'22851	'96180	44	29	0'1635	37322
44	0'3776	80969	7	622'19031	'96224	44	29	0'1606	38957
44	0'3732	84745	8	682'15255	'96268	44	28	0'1578	40562
43	0'3689	88477	9	742'11523	'96311	43	28	0'1550	42141
43	0'3646	92166	10	802'07834	'96354	43	28	0'1522	43691
43	0'3603	95812	1	862'04188	'96397	43	28	0'1494	45213
43	0'3560	99415	2	922'00585	'96440	43	28	0'1466	46707
42	0'3518	*998'02975	3	151981'97025	'96482	42	26	0'1440	48173
42	0'3476	06493	4	152041'93507	'96524	42	28	0'1412	49613
42	0'3434	09969	15	101'90031	'96566	42	26	0'1386	51025
42	0'3392	13403	6	161'86597	'96608	42	26	0'1360	52411
41	0'3351	16795	7	221'83205	'96649	41	27	0'1333	53771
41	0'3310	20146	8	281'79854	'96690	41	25	0'1308	55104
41	0'3269	23456	9	341'76544	'96731	41	26	0'1282	56412
40	0'3229	26725	20	401'73275	'96771	40	26	0'1256	57694
41	0'3188	29954	1	461'70046	'96812	41	24	0'1232	58950
40	0'3148	33142	2	521'66858	'96852	40	26	0'1206	60182
40	0'3108	36290	3	581'63710	'96892	40	24	0'1182	61388
40	0'3068	39398	4	641'60602	'96932	40	24	0'1158	62570
39	0'3029	42466	25	701'57534	'96971	39	25	0'1133	63728
38	0'2991	45495	6	761'54505	'97009	38	23	0'1110	64861
40	0'2951	48486	7	821'51514	'97049	40	24	0'1086	65971
38	0'2913	51437	8	881'48563	'97087	38	24	0'1062	67057
39	0'2874	54350	9	152941'45650	'97126	39	23	0'1039	68119
38	0'2836	57224	30	153001'42776	'97164	38	22	0'1017	69158
37	0'2799	60606	1	061'39940	'97201	37	23	0'0994	70175
38	0'2761	62859	2	121'37141	'97239	38	22	0'0972	71169
37	0'2724	65620	3	181'34380	'97276	37	23	0'0949	72141
38	0'2686	68344	4	241'31656	'97314	38	21	0'0928	73090
36	0'2650	71030	35	301'28970	'97350	36	21	0'0907	74018
37	0'2613	73680	6	361'26320	'97387	37	22	0'0885	74925
36	0'2577	76293	7	421'23707	'97423	36	22	0'0863	75810
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33	0'2063	11280	2	320'88720	'97937	33	17	0'0578	86697
32	0'2031	13343	3	380'86657	'97969	32	16	0'0562	87275
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	-88°.	Diff.	Δ°.	Δ°.	Diff.	89°.		-89°.	Diff.	Δ°.
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						162000'000000				

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MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

APPENDIX TO VOL. LXII.

[*From Proceedings of the Royal Society, Vol. LXIX.*]

With indication of the original pagination.

No. 1.

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“Further Observations on Nova Persei. No. 4.” By Sir NORMAN LOCKYER, K.C.B., F.R.S. Received October 10, 1901.

The last paper* contained an account of the observations of the Nova made at Kensington between March 25 and May 7. The observations are, in the present paper, brought up to September 30. Between June 18 and August 8 no work was done on the Nova, owing chiefly to the interference of buildings and twilight.

* ‘Roy. Soc. Proc.’ vol. 68, p. 399.

Magnitude.

The magnitude has been estimated on sixteen evenings. These seem to afford sufficient evidence that since the beginning of May the star has decreased in magnitude from about 5.7 to 6.7; further, the short variations previously recorded apparently no longer exist, as the estimated magnitudes on eleven nights since the end of August only vary between 6.5 and 6.8.

Photographs of the region about the Nova were taken with the 6-inch Dallmeyer doublet on the evenings of August 25 and September 11, 12, and 18. From these it has been ascertained that its magnitude relatively to those of the surrounding stars is greater photographically than visually.

Visual Spectrum.

The spectrum has been observed with a McClean direct-vision spectroscope on the evenings of August 8, 13, 17, 20, 22, 24, and September 11, 12, 18. The line in the position of the chief nebular line at λ 5007 has always been noted as being the strongest, $H\beta$ and the line at λ 4959 being also present, but comparatively much weaker. Fairly bright lines near λ 472 and the region of $H\gamma$ have also been recorded. Traces of a few lines less refrangible than λ 5007 have been glimpsed, but no determinations of their wave-lengths have been made. No lines have been observed in the yellow or red regions of the spectrum.

Photographic Spectrum.

Photographs have been taken on the evenings of August 9, 15, 17, 21, 22, 23, 24, 26, September 3, 5, 9, 10, 11, 12, 18, 21, 23, 25, 26, with the 9-inch prismatic reflector, the Nova being now far too faint for the utilisation of the 6-inch objective prism, and, until quite recently, in such a position as to make the 30-inch reflector unavailable. These photographs show little or no variation amongst themselves either in the number, position, or relative intensities of the lines. The scale of the photographs is such that the distance between $H\beta$ and $H\epsilon$ is about 0.9 cm. The wave-lengths of the lines have been determined from the best photograph (August 26) by means of an interpolation curve. The presence in the Nova spectrum of some of the hydrogen lines and the helium line λ 4471 was established by direct comparison with the spectra of other stars photographed with the same instrument. These lines were used, together with the 5007 line (the identity of which with the strongest nebula line was assumed), as fiducial lines for the construction of the interpolation curve. The remaining lines were then measured and their wave-lengths read off from the curve. The intensities of the lines as they appear on the plate were also noted.

The spectrum has undergone great modification since the last photographs were taken at Kensington in March and April. The lines are about the same in number and position, but their nature and relative intensities have vastly changed. In the latter part of March and the early part of April the lines were generally broad and ill-defined. They are now narrower, and with better defined edges. The greatest change noticeable in the spectrum is with respect to the relative weakening of the hydrogen lines generally and the alteration in relative intensity amongst some of them. In the earlier photographs the hydrogen lines were very prominent, and the individual members of the series gradually weakened as the ultra-violet part of the spectrum was approached. In the latest photographs they appear of quite secondary importance. $H\beta$, $H\gamma$, and $H\delta$ are all present, but occur only as comparatively weak lines, especially the latter two. With regard to $H\epsilon$, apparently the only other hydrogen line shown, the case is different. The line at or near the position of $H\epsilon$ is now about the second strongest line in the whole photographic spectrum, and many times stronger than either $H\delta$, $H\gamma$, or $H\beta$. With this fact in view, it may be suggested that this strong line is possibly not wholly due to hydrogen, but is mainly a new line of unknown origin, which happens to fall exactly on, or very near to, the position of $H\epsilon$. The line appears to be of much the same nature as the stronger adjacent line at λ 3868. The following table gives the wave-lengths and intensities of the lines visible in the photographs:—

$\lambda\lambda$.	Int. (max. = 10).	Remarks.
3868	10	Strong line in spectrum of planetary nebulae.
3970	8	Probably not wholly due to hydrogen ($H\epsilon$), intensity abnormal.
4102	2	$H\delta$.
4341	2	$H\gamma$.
4364	7	
4471	1	Helium.
4636	3	
4684	2	Probably identical with 4687 of ζ Puppis and Orion stars.
4720	6	
4808	< 1	
4862	3	$H\beta$.
4959	2	Apparently identical with second nebula line.
5007	4	„ „ strongest „

In addition to the lines in the above table, six of the photographs including that of August 26, give indications of the presence of a line in the extreme ultra-violet. Its wave-length could not be obtained

with any degree of accuracy owing to lack of comparison photographs showing lines in the same part of the spectrum, but it is probably identical with the line at λ 342 which von Gothard has independently recorded.*

The enhanced lines of iron, magnesium, &c., which were such a conspicuous feature of the earlier photographs of the Nova spectrum, have now entirely disappeared, and the probability is that the bright lines of the present spectrum other than those of hydrogen and helium belong to gases the terrestrial equivalents of which have not been found. It may be mentioned, however, that in their paper "On the Spectrum of the more Volatile Gases of Air,"† Professors Liveing and Dewar record weak lines at $\lambda\lambda$ $\frac{4363}{4365}$ and 4636 which may possibly have the same chemical origin as the Nova lines 4364 and 4636.

As there is no indication of the new lines forming a series similar to those given by hydrogen and helium, there is probably more than one gas involved.

Characteristics of the Hydrogen and other Lines.

In the series of photographs under discussion, the hydrogen lines no longer exhibit the curious structure described in previous communications, but are much fainter and rather narrower and devoid of any apparent differences in density. Some of the bright lines—notably λ 3868 and λ 3970—are of about the same width as the adjacent hydrogen lines were in the earlier photographs, and show a structure somewhat similar to that illustrated in a previous note.‡

The lines in question appear as triplets, and in each case the most refrangible member is slightly brighter than the others. The lines at λ 4364 and λ 4720 are narrower and less intense than those just mentioned, and put on the appearance of doubles, the brighter members being still on the more refrangible side.

Appearance of the Star.

Visual examination of the star under high powers shows that the Nova has a decidedly larger disc than is possessed by neighbouring stars of similar magnitude. Photographs of the region of the Nova taken on the nights of September 11 and 12, 1901, with a Dallmeyer rectilinear objective of 6 inches aperture and focal length of 4 feet 6 inches, show the penumbral aureole very clearly. It has a fairly definite outline, and is altogether different in character from the

* 'Astro. Nach.,' No. 3738.

† 'Roy. Soc. Proc.,' vol. 67, p. 467.

‡ 'Roy. Soc. Proc.,' vol. 68, p. 234.

images of neighbouring stars of equal magnitude. This peculiarity of the Nova's disc was first remarked by Flammarion and Antoniadi, and later by Max Wolf, Kostinsky, and von Gothard. It owes its origin probably to the exceptionally strong ultra-violet rays emitted by the Nova, which are not brought to the focus for which the objective is corrected.

The recent photographs have been taken by Mr. Butler and Mr. Rolston. The visual observations have chiefly been made by Messrs. Fowler and Butler. Mr. Baxandall has undertaken the reduction to wave-lengths and the discussion of the lines in the photographic spectrum, while Dr. Lockyer and Mr. Baxandall have assisted in the preparation of the present paper.

“Total Solar Eclipse of 1901 May 17-18. Preliminary Report of the Observations made at Ayer Karoe, Sawah Loento, Sumatra.” By H. F. NEWALL, M.A. Received October 30,—
Read at Joint Meeting of the Royal and Royal Astronomical Societies, October 31, 1901.

This expedition was one of those organised by the Joint Permanent Eclipse Committee of the Royal Society and Royal Astronomical Society, funds being provided from a grant made by the Government Grant Committee.

It was originally contemplated that the party should consist of Professor H. H. Turner and myself, and that we should occupy a station inland in Sumatra; but when the former found himself unable to join in the expedition, it was decided not to appoint another observer in his stead, nor to fix upon the station to be occupied until there was an opportunity of learning about local conditions on the spot.

The expedition was to go to Padang, on the West Coast of Sumatra, and to this port I travelled in company with Mr. F. W. Dyson, who went out from the Royal Observatory, Greenwich. It was decided that we should travel out together, prepared either to join forces at one and the same camp, or to form two camps separated by a considerable distance, and our ultimate decision was to depend upon information which we expected to get from the Dutch authorities.

I had communicated with Major Muller, the Chief of the Survey

Department at Batavia, with reference to a possible site for a camp at or near Solok (a station about 40 miles inland on the State Railway), or still further eastwards near the Oembilien coalfields; for it seemed that a station on the east side of the Barisan Mountains would be more likely to have favourable conditions of weather in May than stations on the west side, an opinion based on careful study of both Dr. van der Stok's large work on 'Wind, Weather, &c., in the Indian Archipelago' (Batavia, 1897), and also of the summary published by the Dutch Indies Scientific Society over the names of Major Muller and Dr. Figee, for the information of observers. I may say at once that the reality proved that this opinion, based on averages, was not worth much, for the local conditions seemed, at any rate in 1901, to play a comparatively small part in the determination of weather.

The route chosen for getting to Sumatra was that *viâ* Genoa, and thence by Dutch Royal Mail steamship *viâ* Red Sea direct to Padang, and we are indebted to the Nederland Steamship Company for considerable reduction in fares in consideration of the scientific object of the journey. Mr. Dyson and I and my wife left Charing Cross on March 12, and travelled across the Continent together, and were joined at Genoa by Mr. J. J. Atkinson, who had generously volunteered to go with the expedition to Sumatra to assist in the observations and preparations, as he had done in the previous year with the Astronomer Royal's party in Portugal. We went on board the Dutch mail-steamer "Koningin Regentes," and sailed from Genoa on March 14. The advantages of the route were that it took us in the shortest possible time direct to our port, Padang, lying on the track of the moon's shadow, and gave us the opportunity of making the acquaintance of the Dutch astronomers, who, as we had learnt from Professor Bakhuisen, the President of the Committee charged with organising the Dutch expedition, were going out on the "Koningin Regentes"; and, furthermore, as the boat called at Southampton, it was possible to take the instruments, huts, &c., on the same boat as we ourselves travelled by without transshipment.

Mr. Dyson and I had seen to sending our cases to Southampton, and had personally put some of the more delicate instruments on board the "Koningin Regentes" on March 4. The large 4-prism spectrograph, which I was to use at the eclipse, was kept in use at Cambridge for observations of the Nova Persei until the day of my departure from Cambridge, March 11, when it was dismantled and packed; it was then taken across the Continent, and put on board the "Koningin Regentes" at Genoa. The Dutch observers, Professor W. H. Julius, Professor A. A. Nyland, and Mr. Wilterdinck, also joined the boat at Genoa, as well as a party from the Massachusetts Institute of Technology, Boston, consisting of Professor A. E. Burton, Professor Hosmer, Professor Harrison W. Smith, and Mr. Matthes.

On arrival at Padang on Saturday, April 6, we made the acquaintance of the Governor of the West Coast of Sumatra and of Major Muller, head of the Survey Department, and Mr. Delprat, the head of the State Railways. The Governor received us on the following Monday morning, and we recall with great pleasure the personal courtesy and friendly helpfulness which he at once extended to us. Nothing could exceed the kindness and consideration which we experienced throughout our stay in the island from the Dutch authorities with whom it was our good fortune to come in contact. I may here add that I took the opportunity, which was afforded me by a visit to Java after the eclipse, to express to the Governor-General of the Dutch Indies the informal thanks of the English observers for the generous assistance which had been given to them in their expedition.

We were indebted to Professor Bakhuisen, the President of the Dutch Committee, for several sets of maps of the admirable survey of the West Coast of Sumatra. The local authorities at Padang added to our obligations by presenting us with free passes for ourselves and freight over all the railway system on the West Coast.

The Governor of the West Coast arranged that Mr. Dyson and Mr. Atkinson should make use of his steam launch to inspect possible sites for a camp on the coast in Trusan Bay, and also on an island 6 miles from the coast opposite Painan. Mr. Delprat was able to give me information and much kind assistance in the matter of sites inland near the Oembilien coalfield, and I at once set off to Sawah Loento with introductions to Mr. van Lessen, the Chief Engineer of the mines.

Thus it came about that when Mr. Dyson and I met again at Padang on the following Thursday, April 11, we had gained such information that we were able to decide at once that we should occupy separate camps (i) Mr. Dyson, together with Mr. Atkinson, on the island Aoer Gadang, assisted by H.M.S. "Pigmy," a gunboat commanded by Lieutenant-Commander Oldham, R.N., which, in response to an application from the Royal Society, had been told off by the Admiralty to render assistance to the observers; and (ii) myself inland, on tolerably high ground, not far from Sawah Loento, the last station on the railway, at the mouth of the Oembilien coal mines, and thus quite on the east side of the Barisan Range. Our stations were thus the most widely separated in Sumatra, Mr. Dyson being at the west end of the line, and the first of the Sumatran observers to be immersed in the moon's shadow, whilst I was furthest inland at the east end of the line.

The rest of this report deals with my own experiences and observations.

It was with regret that I had to decline the invitation of the Boston

observers to join forces with them; they had chosen an excellent site on a ridge to the south of Sawah Loento, but it was at a considerable distance from the living quarters, and it seemed to me that in that tropical climate we could not afford to spend much of our forces in walking to and fro, for the somewhat extensive programme of observations would require much preparation. Under the guidance of Mr. van Lessen, the Chief Engineer at the mines, an excellent site was found on high ground above the mines to the N.W. of Sawah Loento; and Mr. van Lessen was good enough to put at my disposal a house close to it, which had recently been built for the use of officers of the mines, but which had not yet been occupied. The house was close to four others in which mine-viewers were living, and, moreover, other houses were being built in their neighbourhood. Hence the conveniences were in every respect very great, for the conditions implied that food supplies would be easily got, water was laid on, and building materials were ready to hand. The house was built on a terrace which had been levelled on the hillside, and I decided to set up the huts and instruments within a few feet of the verandah.

I am very much indebted to Mr. van Lessen for his kind assistance in numberless ways. Not only did he make me free to use the resources of the mines and the coolies employed there, for the purpose of setting up the huts and building piers for the instruments, but he and Mrs. van Lessen helped us in setting up house in rather unusual circumstances, by lending us furniture and in enlisting a similar kindness from the resident "Comptrolleur," Mr. Sieburgh. It is a pleasure to recall the readiness and interest with which the officers of the mines, under Mr. van Lessen's direction, helped us in our needs.

§ 2. *Position of Station.*

The station for the observations was at Ayer Karoe, at the N.W. end of the terrace, on which are built five houses for the overseers of the Oembilien mines. The site is a few hundred yards from the village Doerian, along the road leading from Sawah Loento to Talawi. The position, read off the Survey Map (scale 1 : 20,000), is longitude $0^{\circ} 23' 30''$ E. of Padang, and latitude $0^{\circ} 39' 55''$ S. Major Muller gave the Padang meridian as $100^{\circ} 21' 55''$ E. of Greenwich.

The position of the station may accordingly be taken as—

Longitude $100^{\circ} 45' 25''$ E. of Greenwich.

Latitude $0^{\circ} 39' 55''$ S.

Height above mean sea-level at Padang, 1260 feet.

The spot is about 37 miles from the central line and on the north side of it. The duration of totality predicted from the elements adopted by the 'Nautical Almanac' was $5^m 42^s$, instead of $6^m 29^s$ on the central line.

§ 3. *Time Observations.*

From the top of a small hillock within two minutes' walk of the instruments we could see the camp of the Boston expedition near Sawah Loento, at a distance of 2·7 miles (measured on the Survey maps 1 : 20,000). Professors Burton and Hosmer were so kind as to make an arrangement by which we received time signals and so determined the errors and rates of the chronometer and watch which I had brought with me. Professor Hosmer had a white time-ball fixed that could easily be seen against the dark background of the tropical foliage with the help of binoculars; and it was arranged that on any day that we hung out a signal (three white flags) in the early morning, he would if possible drop the time-ball at 11^h 5^m 0^s, again at 11^h 6^m 0^s and at 11^h 7^m 0^s. His time observations for determining the errors and rates of his own chronometers were made with a 2½-inch portable transit and chronograph. Mr. Hosmer gave me signals on four days between the 9th and 19th of May. My watch—an excellent one by Frodsham, made for the 1862 Exhibition—was kept in exceptionally favourable conditions for good time-keeping, and its rate deduced from signals received on May 9 and 16 was + 4·6 seconds per diem, and from May 16 and 19 was + 4·6 seconds per diem.

The rate of the chronometer (by Crisp) was found to have changed from + 0^s·7 between the 17th and 18th to + 2^s·1 between 18th and 19th, the chronometer having been moved in and out of the hut several times for the preparatory rehearsals.

The following are the times of contacts observed, those predicted from the elements given in the 'Nautical Almanac' being given for comparison and position-angles of the contacts being also added for convenience of record:—

	Position angle.	Prediction, G.M.T.	Observed.
	°	hr. min. sec.	hr. min. sec.
First contact ..	253	16 5 15	16 5 31
Second „ ..	48	17 39 12	17 39 17
Third „ ..	288	17 44 54	17 44 52
Fourth „ ..	82	19 17 20	Not observed

First contact was observed by me through the declination theodolite, the time of my call "Now" (possibly 5 seconds late) being noted on the Crisp chronometer by Lieutenant Briggs. Second and third contacts are those for Dr. Wallace's signal "Go" at beginning of totality when he was observing the disappearing current on the focussing plate of the Dallmeyer telephotographic camera (image of sun 1·43 inches in diameter) and for my signal "Now" given to Lieutenant

Briggs and Mrs. Newall for the exposures they had to make with their respective instruments for the reappearing flash.

These two observations were recorded in terms of the metronome beats, and were connected with the chronometer readings by my noting on the chronometer the instant at which the last call of the count with the metronome was made by the time-keeper.

The metronome was adjusted to beat seconds the night before the eclipse, and as set it lost one beat in 6 minutes. It was tested about a quarter of an hour before the eclipse, and again after the eclipse, and was found in several trials to lose between one and two beats in 6 minutes.

The photographs of the disappearing and reappearing crescents afford a check on these signals called both by Dr. Wallace and myself, but the discussion is not yet completed.

§ 4. *Meteorological Conditions.*

The following summary may be given of the records kept between April 24 and May 22 :—

Becloudedness.—Out of 23 days on which record was kept of the becloudedness of the sky near the zenith between 12 and 1 o'clock midday—the eclipse occurred at 12.22 P.M.—

1 was absolutely free from cloud and haze (May 1).

4 were free from cloud, but more or less hazy.

8 were completely overcast.

10 were more or less cloudy (including the day of the eclipse).

Temperature and Moisture.—The temperature was recorded for wet- and dry-bulb thermometers in the verandah :—

Time of day.....	6 A.M.		Midday.		Evening (about 9 P.M.).	
Number of days on which readings were recorded	19		11		7	
Thermometer.....	Dry.	Wet.	Dry.	Wet.	Dry.	Wet.
Average	72°	71°	84°	78°	76°	74°
Highest.....	76	74	86	80	77	75
Lowest	69	67	80	74	75	72

Rain.—Records on 21 days :—

On only 2 out of 21 days, on which record was kept, was there rain between 6 A.M. and midday.

On 8 days there was no rain.

On 13 days there was rain in the afternoon or night.

Largest rainfalls recorded were :—

May 8	1·19 inches in 40 minutes.
„ 22	1·72 „ 2 hours.

§ 5. *General Programme of the Observations.*

The operations during the eclipse were to include—

1. Taking a series of photographs of the corona with the Dallmeyer telephotographic combination, in continuation of the series obtained in many recent eclipses, under the direction of the Joint Permanent Eclipse Committee.
2. Taking a series of photographs of the corona with the Savart camera, used at Algiers in 1900, for a study of the polarisation of the corona.
3. Taking a series of photographs of polarised images of the coronal with the double-image camera, devised and used by Professor H. H. Turner in recent eclipses.

Nos. 1, 2, and 3 were to be done with the “double-tube” camera, which had been used in many eclipses. Professor Turner had very kindly lent me the apparatus for No. 3, but I had most reluctantly to give up the attempt to adjust it; the weather in the week before the eclipse was unpropitious, and I had to concentrate effort on completing adjustment of instruments already set up.

4. Taking a series of photographs of the spectrum of the chromosphere and “flash” at the beginning and end of totality, with a 4-prism spectroscope with slit, for accurate determination of wave-lengths.
5. Taking a photograph of the spectrum of the corona with the 4-prism spectroscope, two slits being used, to get material for the determination of the relative motion of the eastern and western parts of the corona (rotation of the corona).
6. Taking photographs of the “flash” and corona, with a powerful objective-grating camera, using very high dispersion.
7. Making visual observations of the structure of the green coronal ring, as viewed through another objective grating camera.
8. Taking photographs of the spectrum of the flash and corona with a quartz spectrograph giving small dispersion.
9. Making visual observations of the atmospheric polarisation with a view to detecting a change in the plane of polarisation during totality, and for the purpose of getting the information necessary for adjusting the Savart camera used in No. 2 during the eclipse.

§ 6. *Assistance.*

Throughout the preparations for the observations I received most valuable assistance from my friend Dr. L. Wallace, who travelled from Burma to Sumatra especially to help in the work of the expedition. Arriving at Sawah Loento on April 18, he accompanied us to Ayer Karoe, and assisted in every possible way to further the aims of the expedition from the moment of his arrival until all the instruments were packed up again on May 26 after the eclipse. It is a great pleasure to acknowledge my deep indebtedness to him for his friendly and efficient help.

A few days before the eclipse, Lieutenant-Commander Oldham, of H.M.S. "Pigmy," was good enough to tell off Lieutenant H. D. Briggs to come up to Ayer Karoe, together with two petty officers from the "Pigmy," to help in the final preparations, and in the observations. They took part in the preparatory drills and rehearsals, and gave most efficient assistance.

In the observations during the eclipse itself—

Dr. Wallace was in charge of the double tube camera, and gave the signals, watching the diminishing crescent of the sun upon the blue focussing plate of the Dallmeyer telephotographic camera.

Lieutenant H. D. Briggs exposed the plates for the objective-grating camera, after having assisted me in making the final adjustment with the diminishing crescent.

Mrs. Newall made exposures with the quartz spectrograph.

I made exposures with the 4-prism spectrograph, made observations for detecting the polarisation of the atmosphere, and observed the green coronal ring with the visual objective-grating spectroscope.

E. Hobart, Chief Stoker, and H. Taylor, Petty Officer, H.M.S. "Pigmy," counted seconds aloud from a metronome, and handed plateholders.

At 30 seconds before totality Dr. Wallace, watching the diminishing crescent of the sun, and gauging its length by a marked template which I supplied him with, gave a signal to Lieutenant Briggs, and at 15 seconds he called out "Stand by." Hobart began counting seconds with the metronome, until Dr. Wallace gave the signal "Go," when the disappearance of the crescent showed that totality had begun. Then Hobart ceased counting, and Taylor began afresh, and counted steadily on to the end of the third minute; in this count he began each minute with "one," "two," "three," and Hobart called "One minute gone," "Two minutes gone," at each new minute. Then Hobart resumed the counting of seconds, Taylor calling the minutes up to the completion of the sixth minute, it being expected that totality would last for 5^m 42^s, if the prediction based on the 'Nautical Almanac' elements were true, or for 5^m 32^s if the prediction based on a recent

discussion of eclipse observations were true, Dr. Downing, the Superintendent of the 'Nautical Almanac,' having been good enough to write out to us in Sumatra about this result of the discussion. It was arranged that Hobart should continue the counting of seconds after totality was finished, so that I might note on the chronometer the instant at which the final "sixty" was called.

The operations were rehearsed several times on the two days before the eclipse, and everything went off as perfectly as rehearsals could make it. In a later paragraph reference will be made to one unforeseen mishap which arose from the interference of the clouds.

§ 7. *The Day of the Eclipse.*

When the sun rose and the morning mists were dispelled on the 18th—the day of the eclipse—the conditions seemed vastly more favourable than on any day in the previous week, during which it must be confessed we had rather a trying time, inasmuch as sunshine was needed for the final adjustment of the two spectroscopes, and it was very difficult to find moments between clouds when enough could be got.

The early hours of the morning of the 18th were occupied in completing the adjustments, which, as it turned out, were already nearly perfect, except in the case of the quartz spectrograph, as will appear in a later paragraph. The clocks for driving the cœlostat and the large spectrograph were finally rated, and we had gathered for a last rehearsal, more for the sake of establishing confidence than of adding to the instruction and drill, which had been gone through many times on the two previous days. But about 11 o'clock, very soon after I had observed the first contact, clouds began to move up from the N.E., and to form round the sun, and it began to be an anxious time. I was content to dispense with the rehearsal in dumb-show, and thus avoided the risk of inadvertent exposure of the photographic plates in the dark slides, preferring to give some finishing touches to the arrangements for signals, exposures, and observations. Nothing was lost by this procedure, and in the actual event the programme was perfectly carried out by everyone concerned, except that cloud interfered in an unforeseen way (see § 11, p 221) with my operations with the 4-prism spectrograph, thus curtailing my most important exposure by $2\frac{1}{4}$ minutes, and also involving the loss of one of the exposures with the double tube.

Fifteen minutes before totality the cloud was still hanging about, and obviously forming in some places and dispersing in others. Iris-coloured rings were seen round the diminishing crescent, showing that the clouds were water-clouds, not ice-cirrus. Ten minutes before totality I looked into one of the spectrographic instruments (see

§ 16, p. 231) and failed to distinguish in the dispersed image the light contrast between crescent and cloud. Five minutes later I exposed a plate in the 4-prism spectrograph, using the light reflected from the clouds near the sun; the resulting negative has unexpectedly great density. Four minutes before totality I was able, through a gap in the cloud, to adjust the visual objective grating (see § 17, p. 233), and 2 minutes later to perform a similar adjustment for the photographic objective grating, an operation which 8 minutes earlier I had given up as hopeless. The cloud was a sort of mackerel cirro-cumulus, giving momentary clear views of the crescent, which was more generally partially obscured by the flocculent masses. As the sunlight faded with the waning of the crescent, the visibility of this veil of cloud decreased, but its presence was clearly indicated by the coloured rings.

Cloud continued in greater or less degree throughout the whole of totality, as will be gathered from the record, given in the following paragraphs, of the observations made with the various instruments.

§ 8. *Huts for the Instrument and Dark Room.*

Two huts—wooden framework and Willesden canvas—were taken out to Sumatra.

One was 15 feet 2 inches long, 10 feet 10 inches wide (the length of the sides being multiples of 2 feet 2 inches, the width of the canvas), 6 feet high at the eaves, 8 feet 6 inches high at the ridge. The ridge-pole was not central, but 4 feet 2 inches from one side and 6 feet 6 inches from the other; two canvas-covered doors were provided, one in each long side, at the ends of a diagonal, and the framework of the hut was covered over with Willesden canvas, except over about two-thirds of one side of the roof. To cover this part six thin sheets of the lightest galvanised iron (6 feet by 2 feet, 10 lbs. to a sheet) were used as a roof which could be easily taken off when it was desired to make observations or to let in light and air into the hut, and which, when replaced, formed a water-tight roof that resisted even tropical rain. Over the hut, and quite separate from it, a light bamboo framework was erected by native workmen, and a thatching of rough grass ("alang-alang") was fitted over it, leaving only a space of a foot and a-half between it and the canvas roofing; the thatching was, of course, omitted over the galvanised-iron sheets. This hut was used to cover all the instrument, and was found extremely convenient.

The other hut was 10 feet 10 inches long, 8 feet 8 inches wide, 6 feet high at the eaves, 8 feet 6 inches high at the ridge. It had been used in Algiers for the instrument hut; on the present occasion it was converted into a photographic dark room. For this purpose a roll of Willesden waterproof paper, 5 feet wide, ordinarily used for under-slating, had been taken out to Sumatra, and was used to make the

canvas hut light-tight. The canvas was put on outside the framework, and the roof was thatched with "alang-alang" on the top of the canvas, to help to keep out rain and sun, and the thick paper was tacked in position inside the framework. This was done in such cunning fashion under Dr. Wallace's direction, that the hut was well ventilated, and I doubt if so convenient and comfortable a dark room has ever been constructed in the tropics.

With reference to the dark room, I may add that a good supply of ice for keeping the chemical and washing baths cool was obtained from Padang, but this was only used for the plates that had to be preserved. A great many of those taken in the process of adjusting the instruments were entirely rotted when ice was not used, but as these were only of passing value there was no object in preserving them.

§ 9. *General Arrangement of the Instruments.*

Inside the large hut three piers were built :—

- (i.) One to carry the 4-prism spectroscope and the visual objective grating; top level and oriented north and south.
- (ii.) Another immediately to the west of it to carry the cœlostat; top level and oriented north and south.
- (iii.) A third, still more to the west, to carry the double tube camera, the photographic objective-grating camera and other apparatus, all inclined and pointing downwards towards the cœlostat; top inclined at an angle 22° with the horizon, and in azimuth 70° west of south.

The hut was set so that one diagonal of the base was parallel to the length of the third pier, or in other words, to the double tube camera; the long sides of the hut thus lay nearly east and west. The part of the roof over the N.E. corner was covered with the movable corrugated iron, so as to admit the sunlight to the cœlostat and 4-prism spectroscope below.

The two clocks for driving the cœlostat and the 4-prism spectroscope were put on piers just outside the north side of the hut, and were protected by sheets of corrugated iron leaning against that wall of the hut. The weights for the cœlostat clock were hung over a pulley attached to the bamboo framework that supported the thatch.

The visual polariscopes were fitted to the framework of the hut up in the N.E. corner.

§ 10. *The Cœlostat.*

The 16-inch cœlostat, which was used by Professor Turner in India in 1898, and in Algiers in 1900, had been specially provided, by the care of Dr. Common, with an additional support to the mounting, which made it quite stable and suitable for use on the equator. The

mirror, made by Dr. Common and silvered by the Improved Electric Glow-Lamp Company, had a very fine surface, which was found in admirable condition when it was unpacked and put into its mounting on May 14. All the preliminary adjustments of the polar axis of the instrument had been made by means of the attached declination-theodolite, as in recent eclipses. Dr. Common kindly lent me a 6-inch flat, silver-on-glass mirror (also silvered by the above-named Company), and I used it once or twice before May 14, temporarily fitted to the mounting of the cœlostæt; for it seemed safer in the tropical climate to run as little risk as possible with the 16-inch mirror, though I had, thanks to the kindness of Mr. Hinks, taken out silvering solutions in case of need. The final adjustment of the polar axis of the instrument was completed after the large mirror had been put in position in the mounting, and calls for no special mention.

The tilt of the mirror—*i.e.*, the perpendicularity of its normal to the polar axis—was tested by making the polar axis horizontal, as judged by the readings of the level on the theodolite, and then comparing the readings of a small level carefully placed on a sheet of paper on the silvered surface of the mirror, with the readings of the theodolite level. This procedure was regarded as sufficient and satisfactory for a place close to the equator, though exception might be taken to it were it adopted in higher latitudes.

§ 11. *The 4-prism Spectroscope with two Slits.*

It was intended to attempt—

- (i.) To secure five photographs of the bright-line spectrum of the sun's limb at the beginning of totality, and six others at the end, one slit only being used.
- (ii.) To photograph the spectrum of the corona in both eastern and western equatorial regions to get material for determination of the relative motion in the line of sight (rotation of the corona), two slits being used.

The instrument arranged for this work is a 4-prism spectroscope with two slits. It was used by the writer in India at Pulgaon in 1898,* and at Algiers in 1900.†

The train of prisms is of such dimensions and construction as to transmit a 2-inch beam of light and to produce a minimum deviation of 180° for H_γ . The camera and collimator are set parallel to one another.

The whole spectroscope is mounted so as to turn about an axis

* 'Roy. Soc. Proc.,' vol. 64, p. 55; 'Monthly Notices, Roy. Astro. Soc.,' vol. 58, App. p. [55].

† 'Roy. Soc. Proc.,' vol. 67, p. 356; 'Monthly Notices, Roy. Astro. Soc.,' vol. 60, App. p. [20].

parallel to the collimator. The axis is rotated (with a period of 24 hours) by clockwork, and is tilted so as to be parallel to the earth's axis. It was adjusted so that the collimator pointed to the south pole and the camera to the north pole.

The tube of the collimator is prolonged beyond the plane of the slit, and is arranged to carry at its end a mirror of speculum metal and an object-glass, by means of which an image of the sun can be thrown between the two slits.

The whole arrangement thus consists of a spectroscope combined with a polar heliostat, and in virtue of the fact that the spectroscope is rotated together with the mirror, the image of any celestial object thrown on the slit does not rotate relatively to the slit. The mirror is mounted in such a manner that the axis about which it is tilted can be oriented relatively to the collimator tube, so that the slits may be set parallel to any diameter of the sun. On the present occasion the slits were set parallel to the axis of the sun.

In India the slits were set at too great a distance apart, and the light of the corona was not strong enough to impress the photographic plate; the slits were set so as to catch the corona nearly 8' from the sun's limb on each side. In Algiers the instrument was used with only one slit, and the spectrum of the corona was photographed in two regions to a distance $3\frac{1}{4}'$ from the limb with an exposure of 49 seconds, and the resulting negative was a good strong one. In Sumatra I expected to be able to get an exposure of 270 or even 300 seconds, and to avoid risk of disappointment the slits were set at such a distance apart as to catch the corona 3' from the sun's limb on each side. This distance was as small as it seemed wise to adopt, account being taken of the apparent diameter and movement of the moon during totality.

The instrument was fairly well adjusted on May 2, and I then took the opportunity afforded by a clear night to throw an image of the full moon on to the slits. It was brightly seen and easily adjusted; but to make matters more certain, I painted the slit-plate white, so that there might be no possible difficulty in setting the image of the corona between the slits after the exposures had been made for the "flash" spectrum with the crescent across one of the slits. The sequel will show that even this precaution was not enough under the circumstances.

The adjustment of the axis of the instrument to parallelism with the earth's axis was accomplished in the same way as in India and Algiers by means of a theodolite with declination circle and level, which was attached to a part of the frame of the spectroscope specially prepared for it.

The rotating plate-holder, charged with twelve small plates, was again used for the exposures as in Algiers.

I was observing the diminishing crescent through the guiding eye-piece of the spectroscope when Dr. Wallace called out "Stand by," and at once hastened to the plate-holder to make exposures for the "flash." Five exposures had been made, each twice as long as I had intended to make had there been no cloud, and as the counting went on longer than I anticipated I decided to make one more exposure, thus using a sixth plate at the beginning of totality. Immediately after having moved Plate No. 7 into its place with shutter closed, I returned to the guiding eye-piece to set the corona ring between the slits. I could see one side of the faint ring distinctly, but could not see the slits, but having learnt by experiment in the course of the morning what movements of the declination and R.A. slow-motions were required to move the image from one position to the other, I made those movements and, being still unable to see the slits, looked up at the corona. There was no difficulty in seeing the dark moon, so to speak, but the corona was quite indistinct beneath the cloud, and was surrounded by a colourless bright ring, which is referred to in the "General Remarks." My notes, written directly after the eclipse, contain the following:—

"I heard count 'Thirty,' and took a candle lamp [which was standing in the tent] to try to illuminate the slit-plate, but failed to get light in. Then, as 'Thirty-five' was called, I turned to polariscope. No trace of polarisation. Turned to second polariscope and could see no trace of polarisation, but saw mackerel sky very strong as it seemed, all over region near the sun, especially to N.E. . . . Returning to 4-prism spectroscope I found the whole ring of the corona visible, but still could not see the slits. Tried candle again; no use. 'Two minutes gone' was called. Ring was clearly lighter, but slit not visible; cloud pretty strong over corona, which could only be traced about half a diameter from the limb. I walked towards double tube and met W. [coming back into hut], who was I thought waiting for improvement in cloud. He asked, 'Is Savart set.' . . . [I replied 'Yes' and] he at once exposed plate-holder No. 2 in the double camera, and I heard '2^m 35^s' called as I walked back to spectroscope. Corona was brighter, and I found slits visible, and moved corona ring on to the right place and exposed at 2^m 45^s [having lost two minutes and fifteen seconds, exactly half the intended exposure]. Then I turned to polariscope and still failed to see any bands, and then went to visual grating . . . Clouds seemed thinner when I looked up at sky, and Mercury and Venus were very bright. I had one more look at corona on the slits of 4-prism [and found it still correctly adjusted on the slits, and the clockwork evidently driving well], and then as Briggs came back into hut, I looked at polariscope for third time and again failed to see any bands on sky. At 5^m 0^s I saw B. and Mrs. N. close their exposures, and I closed mine at 5^m 3^s, the rubber band of

shutter sticking rather. Then re-set bright side of corona according to picture [previously made to indicate position angle of crescent on slit], and began to expose the five remaining plates in 4-prism [for second 'flash']. At 5^m 35^s I called 'Now' to Briggs and Mrs. N. for their final photographs, when I felt end of totality had come . . . [I turned to chronometer and waited for] W.'s signal 'Now,' which was to mean the 15-seconds crescent [of returning sun]. I noted this on chronometer, and waited further for Hobart's final 'Sixty,' which I also noted on the chronometer. Called 'Cover slides,' and then went out of hut and saw mackerel cloud all over the sky near the sun and 'glory' rings coloured round crescent. Sky got rapidly more clouded, and clouds drifted slowly towards west. Collected notes from observers."

Summary of Exposures.—Six exposures were made near second contact with the following durations :—

1 second, 1 second, 2 seconds, 2 seconds, 2 seconds, 3 seconds.

The seventh plate was exposed for the corona spectrum for 2^m 18^s. Five exposures were made near third contact with the following durations :—

2 seconds, 2 seconds, 1 second, 1 second, 1 second.

Results.—Of the twelve plates thus exposed, only four plates show any impress of the light. The rest, including the exposure on the corona, show nothing, though development was pressed as far as possible.

Five minutes before totality a photographic plate was exposed for 15 seconds to get the spectrum of the sunlight reflected from the clouds near the crescent—this was to serve to give standard measurements to which the measures of the corona spectrum were to be referred—and a good strong negative was obtained.

The plates at second contact are very feeble negatives, and I attribute their weakness to cloud. Photographs obtained with the other instruments at the beginning of totality show that at least three-quarters of the light was intercepted by cloud.

The spectrum of the corona failed because of insufficient exposure under the cloudy conditions.

The plates at the end of totality, when there was certainly very much less cloud, show no sign of impress of the light, and I can only explain it by assuming that the image of the reappearing crescent must have been set across the slit in such a way that three or four more exposures than I had the means of giving were needed to catch the reappearing chromosphere. Photographs obtained with the objective grating show that there was plenty of light to impress the plate, if only it had passed into the slit.

§ 12. *Dallmeyer Telephotographic Camera.*

The double camera used by Professor Turner at Sahdol in 1898 and at Algiers in 1900 was used on the present occasion in the modified form adopted at Algiers. One of the 7×7 -inch tubes contained the photoheliograph objective No. 2, of 4-inch aperture and 5-foot focal length, with a Dallmeyer secondary magnifier of $7\frac{1}{2}$ inches focus, placed 5 inches within the focus, giving an image of the sun 1.43 inches in diameter on plates $6\frac{1}{4} \times 6\frac{1}{4}$ inches.

The method adopted for focussing was first to focus on trees on a distant hill top, viewed through blue glass, and then to use the collimating process, adopted in many recent eclipses. A plane mirror set perpendicular to the axis of the camera reflects rays emerging from the objective back again through the objective; the image of objects in the focal plane is thus formed in the focal plane. The mirror used on the present occasion was the 6-inch kindly lent to me by Dr. Common, and a negative, specially prepared with an image of a finely graduated scale in white on a black ground, was used as the object to be focussed on a sensitive plate, which was put in the same plane with it. Four trials gave sufficient data to set the focus accurately.

The results obtained in the eclipse are as satisfactory as the lenses will give, and it seems right to suggest that some other lenses be used, if it is decided to take this kind of photograph of the corona in future eclipses.

The programme of exposures with this camera was of necessity the same as that adopted for the polariscopic images referred to in § 13, p. 227, for the exposures were made by means of the one shutter for both cameras. The six slides were filled with Ilford Empress plates, and all six were to be exposed during totality if circumstances allowed. It was intended, if the sky was clear, that the exposures should include the series, 2^s , 4^s , 8^s , 16^s , 32^s , and another long one (120^s) with diminished aperture; and in case of cloud the long exposure was, if necessary, to be sacrificed altogether, and the exposures in geometrical series were to be secured, if possible, in clear intervals. The order of the exposures was to be:—

1. 8 seconds, followed by an interval in which the Savart camera would be set by me after visual observations of the atmospheric polarisation had been made.
2. 16 seconds.
3. 32 seconds, after which Dr. Wallace was to put a cap on the lens to diminish its aperture.
4. Long exposure, to be sacrificed if necessary; after this the cap was to be removed again from the lens.
5. 4 seconds.
6. 2 seconds.

In the event, the long exposure was sacrificed, the other five were made.

The actual exposures were :—

1. 8 seconds, beginning 10 seconds after the signal "Go."
2. 17 " " 2 minutes 35 seconds after the signal "Go."
3. 36 " " 3 " 15 " (± 5 seconds).
4. Omitted.
5. 4 seconds, beginning 5 minutes 3 seconds after the signal "Go."
6. 2 " " 5 " 18 " " "

The first exposure was made through clouds.

The interval between the first and second exposures was more than 2 minutes longer than it would have been had the sky been clear. In the third exposure one of the shutters had evidently not acted, the photograph showing nothing but the standard squares, which had been put on just before development. The last two exposures were carried out according to programme, and were made probably at moments when the sky was clearer than at any other time during the whole eclipse.

The Standard Squares.—After the eclipse, Sir. W. Abney's standard squares were impressed on all the plates for photometric measurements. Exposures were made to a standard candle at 5 feet from the plate, and, following a suggestion made by Professor Turner after his experience with the plates taken at Algiers in 1900, two sets of squares were impressed, with different exposures, on all the plates, as follows :—

Plate.	Exposure for corona.	Exposure for standard squares.		
No. 1	8 seconds	10 seconds and 5 seconds		
" 2	17 "	20	"	5 "
" 3	36 "	80	"	5 "
" 4	not exposed	80	"	5 "
" 5	4 seconds	80	"	5 "
" 6	2 "	20	"	5 "

Development.—All the plates were developed with metol.

When it was found that there was no image on No. 3—one of the exposing shutters evidently had not acted—it was thought wise to impress squares on No. 4, and develop it, just for the very improbable chance that it had been exposed in mistake for No. 3, but no image appeared on the plate.

Results.—The four photographs obtained are all good clean plates. The effect of the cloud is clearly seen in the plates, though it is surprising that the definition has not been more affected by it. The first exposure (8 seconds) shows less than the last (2 seconds);

and the second (17 seconds) shows very little more than the fifth (4 seconds).

The form of the corona is clearly of the type associated with the minimum in the sunspot cycle.

The eastern equatorial region shows great disturbance, and there are many striking prominences on the eastern limb and several marked arches. In particular, reference may be made to (i) two dark rifts radiating from the neighbourhood of a prominence near the sun's equator, on the east side; (ii) bright and dark arches in no less than three of the quadrants, extending about 4' from the limb; (iii) a dark region surrounding a large prominence whose position-angle is approximately 20° measured from the N. point of the sun; and (iv) a remarkably definite edge as of a chromospheric layer for a considerable arc of the sun's limb, in the N.W. quadrant, such as Sir Norman Lockyer described as seen in the photographs secured in Spain last year.

A summary is given below of the extension noted in the different photographs—extension being measured beyond the *moon's* limb, and expressed in minutes of arc:—

	Plate No. 1. 8 seconds.	No. 2. 17 seconds.	No. 5. 4 seconds.	No. 6. 2 seconds.
North polar streamers	5'	15'	21'	5'
East equatorial	8	23	19	8
West „	5	22	12	9
South polar	3	10	8	4

§ 13. *The Polariscopic Camera (Savart Plates and Nicol Prism).*

The Savart camera, which was constructed for use in Algiers, was to be used on the present occasion with a view to getting information as to the amount of polarisation in the outer regions of the corona, and, in particular, in the search for the position of maximum polarisation.

Professor J. J. Thomson very kindly put the large Nicol prisms from the Cavendish Laboratory collection at my disposal again, and the Savart plates were arranged in the same way as last year.*

The camera was put in the second compartment of the double tube, side by side with another camera which was provided with a similar lens, but had no polarising apparatus in front. In this way images of the same scale were obtained side by side on the one plate, one image being taken through the polariscopic camera, the other through the plain camera, each camera having an aperture approximately F/27.

* 'Proc. Roy. Soc.,' vol. 67, p. 363; 'Monthly Notices, Roy. Astro. Soc.,' vol. 60, App., p [27].

The cameras were focussed on trees on a distant hill viewed through blue glass, and gave satisfactory images.

The programme of exposures was the same as that for the Dallmeyer telephotographic camera, as follows :—

8 seconds, 16 seconds, 32 seconds, 120 seconds, 4 seconds, 2 seconds, thus including one long exposure, and five others in geometrical progression, it being intended to compare the polarised image on one plate with the unpolarised image on the plate next before it in the series. The Savart was to be set in accordance with the result of visual observations of the atmospheric polarisation, so that the bands due to atmospheric polarisation should be obliterated. The first photograph was made with an arbitrary setting of the Savart, and the setting chosen was one that would give the coronal bands slightly inclined to the sun's equator. In the event no atmospheric polarisation was detected, and the Savart was left at the same setting throughout all the exposures. Mr. Wallace made simultaneous exposures for these and for the Dallmeyer telephotographic camera.

Results.—As in the case of the Dallmeyer telephotographic camera, four photographs were obtained, standard squares being impressed on each plate after the eclipse with a standard candle at 5 feet.

	Exposure for corona.	Exposure for standard squares.
No. 1	8 seconds	10 seconds and 5 seconds
„ 2	17 „	20 „ 5 „
„ 5	4 „	20 „ 5 „
„ 6	2 „	— „ 5 (one only).

All the photographs with the Savart camera are good clean plates and show marked polarisation of the corona. The following table summarises the extensions of the coronal streamers in the unpolarised images and of the bands in the polarised.

Extensions expressed in Minutes of Arc from Moon's Limb.

P = Polarised Image. U = Unpolarised.

Plate.....	No. 1.		No. 2.		No. 5.		No. 6.	
Exposure	8 seconds.		17 seconds.		4 seconds.		2 seconds.	
	U.	P.	U.	P.	U.	P.	U.	P.
North polar streamers	8'	?	20'	28' (?)	15'	10' (?)	8'	?
East equatorial	13	57'	46	69	29	28	15	10'
West „	8	49	41	97	29	34	20	23
South polar	5	?	16	?	11	?	8	?

In estimating extensions in the unpolarised images no account was taken of light, which it seemed fair to attribute to diffusion from clouds. Extension was gauged along *streamers*, not in structureless luminosity. In many cases bands can be traced in the polarised images further than streamers in the unpolarised.

Many years ago Sir G. G. Stokes pointed out that the Savart polariscope might be used for the detection of faint extensions of the corona, and it may be that these photographs give evidence of the value of that suggestion.

Across the dark moon very faint bands are detectable only in the 17-second exposure. I am not yet prepared to say how far the discussion of the results may lead me to attribute the extension of the bands to the diffusion of polarised light which emanates from the corona by terrestrial clouds, but it is clear that the resultant polarisation of such light must be, so far as the Savart bands are concerned, in a plane parallel to the equatorial extensions.

The value of the photographs, *as a series*, with related exposures is much interfered with by the variation in the effect produced by cloud, and in consequence it will hardly be possible to utilise them for finding at what distance from the sun there is the maximum relative polarisation, even were the impressed extensions great enough. But as each plate had two exposures made on it simultaneously, one of the polarised image and one of the unpolarised, it is anticipated that they will serve well for the determination of the amount of polarisation in many regions of the corona.

The accompanying figure (fig. 1) indicates the contours of equal brightness in the two images, polarised (dotted line) and unpolarised (unbroken line) obtained in the second (the longest) exposure. It is reduced from a drawing made on a screen on which the two images were successively thrown by means of a lantern. The most marked streamers in the corona are indicated as well as the contours. No great precision has been aimed at in the diagram, its object being merely to give an idea of the sort of material obtained for the investigation. The phenomena are somewhat complicated; in consequence of the radial polarisation of the corona, the bands in the quadrants through which the central band passes form a system with white centre, those in the other quadrants form a system with dark centre; the two systems meet along lines passing through the centre and inclined at 45° to the central band. Hence some care must be exercised in interpreting the appearances presented.

§ 14. *Atmospheric Polarisation.*

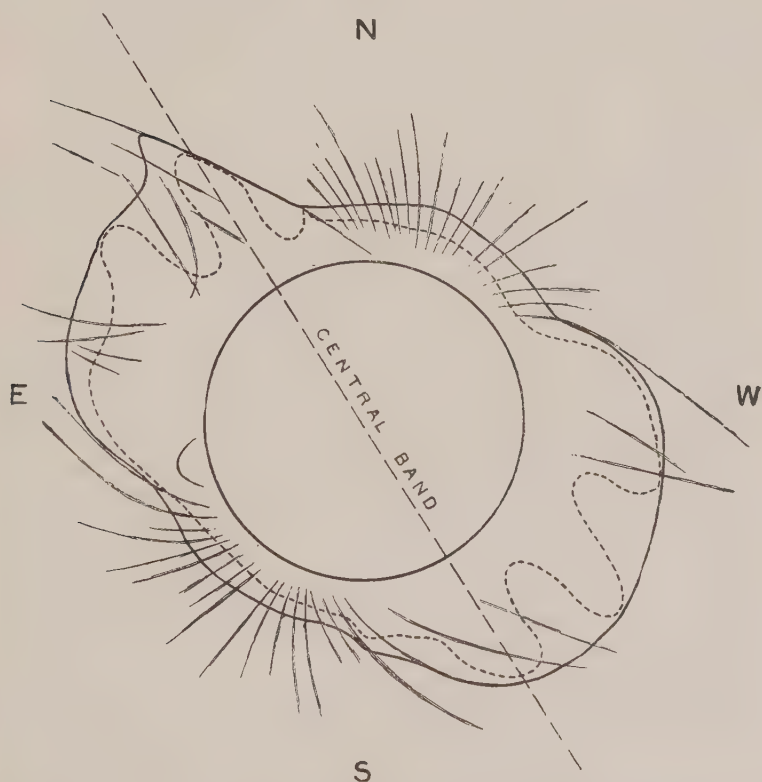
The Savart polariscopes A, B, and C were fixed on the framework of the hut in such position that the sky in the neighbourhood of the

eclipsed sun could be seen through them. Each was mounted in a turning tube, provided with a pointer and graduated circle and attached to a wooden stand.

The programme of observations was that I should look through A as soon after the beginning of totality as the adjustment and exposures of the 4-prism spectroscope would set me free. The polariscope was to be then turned in its tube until the Savart bands were invisible, and

FIG. 1.

N



I was at once to set the large photographic Savart camera to the corresponding reading, and to call out to Mr. Wallace, who was making the exposures for that camera.

Next the polariscope B was to be used half-way through totality, when my visual observations with the grating-spectroscope were completed. Finally the polariscope C was to be used towards the end of totality, just before the fifth minute was completed. Each of the polariscopes was to be left as adjusted "for extinction," and the readings were to be made at leisure after the eclipse, except in the case of A, of which the readings were needed at once.

Result.—In the event I used A about 40 seconds after the beginning of totality, and found no trace of polarisation in any position of the instrument. To make sure that nothing was wrong I used also polariscope B, and corroborated the first observation.

Towards the end of the third minute—2^m 50^s from the beginning of totality—I again observed with B. At the end of the fifth minute I used C; and in neither case could I detect a trace of atmospheric polarisation. About 3.50 P.M., after the eclipse was over, I used the polariscopes again, and found them all as adjusted in the morning before the eclipse; each one showed strong bands on the patches of blue sky visible in the field of view.

§ 15. *The Quartz Spectrograph.*

It was intended to attempt to get—

- (i) Photographs of the ultra-violet spectrum of the flash at the beginning and end of totality.
- (ii) A photograph of the ultra-violet spectrum of the corona.

The instrument was fixed on the top of the double tube, and was supplied by light from the coelostat. The arrangement was such that the slit could be set, without readjustment of the image, to catch the crescents both at beginning and end of totality, and the corona during totality. No other medium but quartz was used in the lenses and prisms, and the dimensions were such that a 2-inch beam was transmitted. The image lens had a focal length of 20 inches, and the collimator and camera lenses were each of focal length 18 inches; the prism was compounded of two 30° prisms, one of right-handed and the other of left-handed crystal; all the optical parts were constructed by Hilger. Unfortunately it was found impossible to get the adjustments completed before the eclipse.

On the morning of the eclipse a final attempt was made, and it was thought well to make the exposures according to programme. These were all duly made, but the adjustment was so imperfect that the photographs are useless, which is all the more regrettable as the plates show strong spectra.

§ 16. *Photographic Objective-grating Camera.*

It was intended to attempt to get—

- (i) Photographs of the “flash” spectrum with high dispersion in a limited range of spectrum, to assist in the discussion of the origin of lines, whose wave-lengths it was hoped would be determined accurately by means of the 4-prism spectroscope.
- (ii) A photograph of the blue coronal ring near λ 4231, for comparison with the visual observations of the green coronal ring.

The instrument employed was in essentials that used at Algiers in 1900, but it was mounted differently.

A plane grating by Rowland, 14,438 lines to the inch on a ruled surface $5 \times 3\frac{1}{2}$ inches, was fitted on an axis in front of a telescope of aperture 4 inches and focal length 66.8 inches. The grating is a very brilliant one; the objective is an excellent one, corrected for photographic rays, by Cooke and Sons; and both belong to the splendid spectroscopic installation arranged by the late Professor Piazzi Smyth. I am under great obligation to the Royal Society for the continued loan of this outfit.

The telescope with grating attached was fixed inclined at an angle of 20° to the horizontal and pointing downwards on the sloping pier which supported the double camera, the telescope and camera being parallel. Part of the beam reflected by the coelostat was allowed to fall on a 6-inch mirror, and thereby reflected downwards on to the grating. By inclining the plane of this reflection by the proper amount with the vertical, it was possible to get the crescent at second contact symmetrically disposed with respect to the plane of dispersion of the grating. It was thought best to run the risk involved in the loss of light for the sake of getting the telescope into the very convenient position of parallelism with the double camera, and on the same sloping pier with it.

The light reflected by the small mirror fell upon the grating with an incidence of 39° , and the diffracted beam left the grating at an angle of about 5° on the other side of the normal. In this position H_γ in the spectrum of the second order was not far from the centre of the field of view of the telescope.

The focussing and final adjustment of the spectrum on the focussing plate was intentionally left to be done a few minutes before totality, when the width of the diminishing crescent would make it possible to recognise the exact part of the spectrum in the field of view. Ten minutes before totality the cloud was so obscuring that on looking into the eye-piece I could not distinguish between the spectrum of the crescent and light reflected from the clouds. Returning to the instrument 6 minutes later I found the lines visible, and Lieutenant Briggs, who was to take charge of the exposures with this instrument, turned the tilting screw of the grating till I could see that the dark crescent-shaped lines near $\lambda 4231$ were in the centre of the field. I then focussed very carefully, and handed over the instrument to Lieutenant Briggs.

Programme.—Exposures were to be made—

(i) For 1 second when the signal "Stand by" was called by Dr. Wallace 15 seconds before totality.

(ii) For 2 seconds when the count "Thirteen" was called before totality.

(iii) For $4\frac{1}{2}$ minutes, starting at the count "Thirty" after the beginning of totality and ending at the count "Sixty,—five minutes gone."

(iv) For 2 seconds, when I gave the signal "Now" at the end of totality.

Lieutenant Briggs carried out the programme with admirable precision.

Result.—All four photographs are of value. The first serves for determination of the scale of the spectrum and shows that the focussing was very successful. The second and fourth photographs show both bright and dark lines, as was intended; the second is a weak negative, but is full of interesting details; the fourth is quite strong, teeming with bright crescents, of which more than ninety have been counted between λ 4308 and λ 4405. Many of the crescents are bright throughout their whole length; many are reversed in the middle; some of the bright crescents are accompanied by dark crescents on either side; others have a dark crescent only on one side or the other; all varieties seem to be represented.

The third photograph is not very strong but it shows marked continuous spectrum, with the blue coronal ring distinctly though not easily visible. The edges are ill-defined, in marked contrast with the sharp prominence-tips that serve to mark out the positions of the H_γ and H_δ chromospheric rings.

The radial extension of the blue coronal ring is about $3'$, but there is no sign of radial structure.

Two determinations of the wave-length of the light forming the blue ring give the values 4231.4 and 4231.9, if the wave-lengths ascribed to the dark H_γ and H_δ lines may be adopted for the bright hydrogen prominences.

The dispersion is about 5.14 tenth-metres to a millimetre, and the scale of the ring is such that its diameter corresponds to 65 tenth-metres. The conditions are thus favourable for the detection of coronal rings. No ring except that at 4231 has been with certainty detected between H_γ and H_δ .

§ 17. *Visual Objective-grating Spectroscope.*

An objective grating spectroscope was used as in India, in 1898,* for visual observations of the green coronal ring, with a view to (i) repeating the search made during the Indian eclipse for fine radial streamers, (ii) comparing the distribution of light in the green ring with that in the blue ring near λ 4231, of which I hoped to get a photograph with a photographic objective grating camera.

A plane grating by Rowland, 14,438 lines to the inch, on a ruled

* 'Roy. Soc. Proc.,' vol. 64, p. 57; 'Monthly Notices, Roy. Astro. Soc.,' vol. 58, App., p. [57].

surface $3\frac{1}{2} \times 2\frac{1}{8}$ inches, was fixed on a turn-table in front of a telescope of aperture $3\frac{1}{2}$ inches, and focal length 29 inches. A positive eye-piece with two cross-wires was used, which gave a magnifying power of 19.2, and whose circular field of view was rather more than 1° in diameter.

The instrument was mounted so that the telescope was parallel to the earth's axis and pointed to the south pole. The grating was used in a manner analogous to that in which the mirror of a polar heliostat is used. The light of the corona was incident at an angle of about 57° , and the diffracted beam utilised in the telescope left the grating at an angle of about 13° . In this position of the grating, the green of the second order was used and the magnifying power of the grating was approximately one-half, so that the distorted coronal ring was an ellipse, of which the major axis was about twice as long as the minor axis, the minor axis being parallel to the length of the spectrum and perpendicular to the direction of daily motion. No clockwork was used, but a wedge pushed under a wooden arm fixed to the instrument and projecting radially outwards from the telescope served to give a satisfactory slow motion by slightly turning the whole instrument about what may be described as polar pivots.

The instrument was focussed on the E group of lines about two minutes before totality began. The crescent was small enough to show the lines sharply, though the instrument was so set that the point of second contact was near the end of the major axis of the distorted image.

When I came to make observations of the green coronal ring, I first looked very carefully for fine radial structure; and finding none, I altered the focus very slightly. This did not improve matters, so I reverted to the original focussing, and am quite satisfied about the observation, which could not be more definite.

The observations were begun after the completion of the third minute of totality and were completed in about 80 seconds. Two ellipses had been drawn beforehand to serve as outline for the distorted limb of the moon; and on one of these the record of contour lines of the brightness was quickly but carefully sketched.

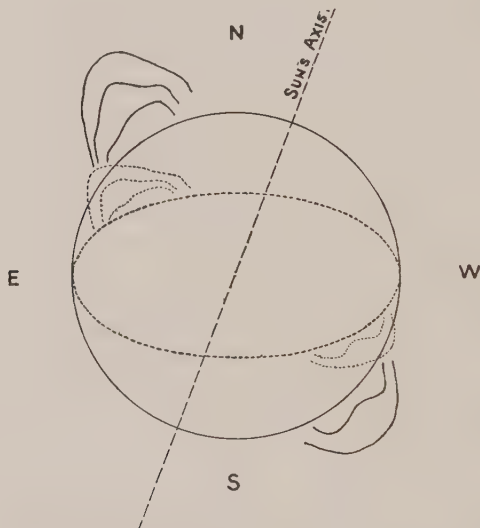
Results.—The coronal ring was distinctly seen, but there was a good deal of other green light throughout the whole of the field of view, doubtless from clouds. No fine radial structure could be seen anywhere round the ring; but there were two broad patches of the light of "coronium" projecting from the elliptical ring.

The accompanying figure (fig. 2) shows by the dotted lines the ellipse drawn beforehand, and the contour lines as sketched in during the eclipse. The unbroken lines indicate the results got by projecting the ellipse into a circle and making the corresponding change in the contour lines.

§ 18. *General Observations.*

The general darkness during totality was greater than that in India, 1898, and in Algiers in 1900, but not so much greater as was anticipated from the great length of duration of totality. No integrating photometer was used. Lamps and candles were provided in case of need, but they might have been dispensed with except for one adjustment.

FIG. 2.



The figure shows, by contour lines of equal brightness, the position of the two bright patches of incandescent "coronium" seen in the corona.

During totality I noted several times an uncoloured ring of light round the moon. It was evidently of terrestrial origin—in fact, a ring such as apart from an eclipse would be described as a "corona." The radius of the ring was estimated as about 1 or $1\frac{1}{2}^\circ$. The equatorial streamers of the true solar corona were estimated as being visible not further than a quarter of a degree from the moon's limb, being then lost in general diffused light. The peculiar feature about the ring, as a phenomenon of diffraction due to the small particles of water forming the cloud to which it was without doubt due, was that the maximum of brightness appeared to be in the ring itself rather than near its centre. After totality colours again appeared in it, but I did not note nor can I recall the diameter of the rings.

"Total Eclipse of the Sun, 1901 May 18. Preliminary Account of the Observations made at Pulo Aoer Gadang, West Coast of Sumatra." By F. W. DYSON, M.A., F.R.S., Sec. R.A.S. Received October 24,—Read at Joint Meeting of the Royal and Royal Astronomical Societies, October 31, 1901.

I. General Arrangements.

The Admiralty having approved of expeditions from the Royal Observatory to observe the Solar Eclipse of 1901, May 18, I was instructed by the Astronomer Royal to occupy a station on the West Coast of Sumatra with the instruments used at Ovar in the eclipse of 1900, May 28. Mr. J. J. Atkinson, who accompanied the Observatory expedition to Ovar, again generously volunteered his assistance and is associated with me in all the observations. His advice and co-operation were of the greatest value throughout.

The programme of observations, which was arranged in concert with the Joint Permanent Eclipse Committee, was essentially the same as that carried out at Ovar.

The 16-inch cœlostat and the 4-inch rapid rectilinear (Abney) lens were lent by the Royal Astronomical Society, and Captain Hills kindly lent the spectroscopic equipment he used at the Indian eclipse, viz., a two prism flint spectroscope, a four prism quartz spectroscope, and a 12-inch heliostat.

At the request of the Royal Society the Admiralty placed H.M. gunboat "Pigmy" at the service of the observers in Sumatra. We are indebted to Lieut. and Com. Oldham for the ready manner in which he assented to our request to anchor off Gadang, and let us live on the "Pigmy." Without his cordial co-operation this station could not have been occupied. We are further indebted to him and to the officers and men of the "Pigmy" for assistance in erecting the huts and instruments, and for the large share they took in the observations on the day of the eclipse.

We received every assistance from the Government of the Dutch East Indies in the choice of station and arrangement with the natives, and were given free passes for ourselves and instruments on the railways. We are specially indebted to Mr. Joekes, the Governor of the West Coast of Sumatra, to Mr. Von Locken, the Assistant Resident at Painan, to Major Müller, the Director of the Ordnance Survey and Chief of the Dutch eclipse party, and to Mr. Delprât, the Director of Railways.

Itinerary.—The observing huts and instruments having been despatched some days previously, the 16-inch cœlostat mirror and some of the photographic plates were taken to Southampton and put

on board the Dutch mail steamer "Koningen Regentes," at Southampton, on March 4. The observers joined the ship at Genoa, on March 14, and sailed in company with Mr. and Mrs. Newall, the Dutch eclipse party, and an American eclipse party from the Massachusetts Institute of Technology, direct to Padang in Sumatra, arriving there on April 6.

In consultation with Mr. Joeckes the Governor of the West Coast and Major Müller the Director of the Ordnance Survey as to choice of station, it appeared that the small island of Pulo Aoer Gadang might be suitable, and the Governor kindly offered us the use of his yacht to visit the island on March 10. In company with Mr. Von Locken we chose a suitable site and made the necessary arrangements with the native chief who owned the island. Lieut. and Com. Oldham conveyed us with our instruments and materials for building huts to Gadang on March 13, and remained anchored off Gadang, except for short necessary visits to Padang for ice, fresh meat, &c., till May 25, one week after the eclipse. On this day the instruments were brought back to Padang for shipment to Europe, and the observers were conveyed to Singapore, which was reached in the early morning of June 2.

Station.—The particularly uncertain character of the weather in Sumatra made it desirable that stations as far apart as possible should be occupied by the different parties of observers. The stations occupied by different expeditions are shown on the accompanying map (A).

Sawah Loento, by Mr. Newall and by a party from the Massachusetts Institute of Technology.

Solok, by numerous American observers of the United States Naval Observatory expedition.

Fort de Koch, by American and Dutch observers.

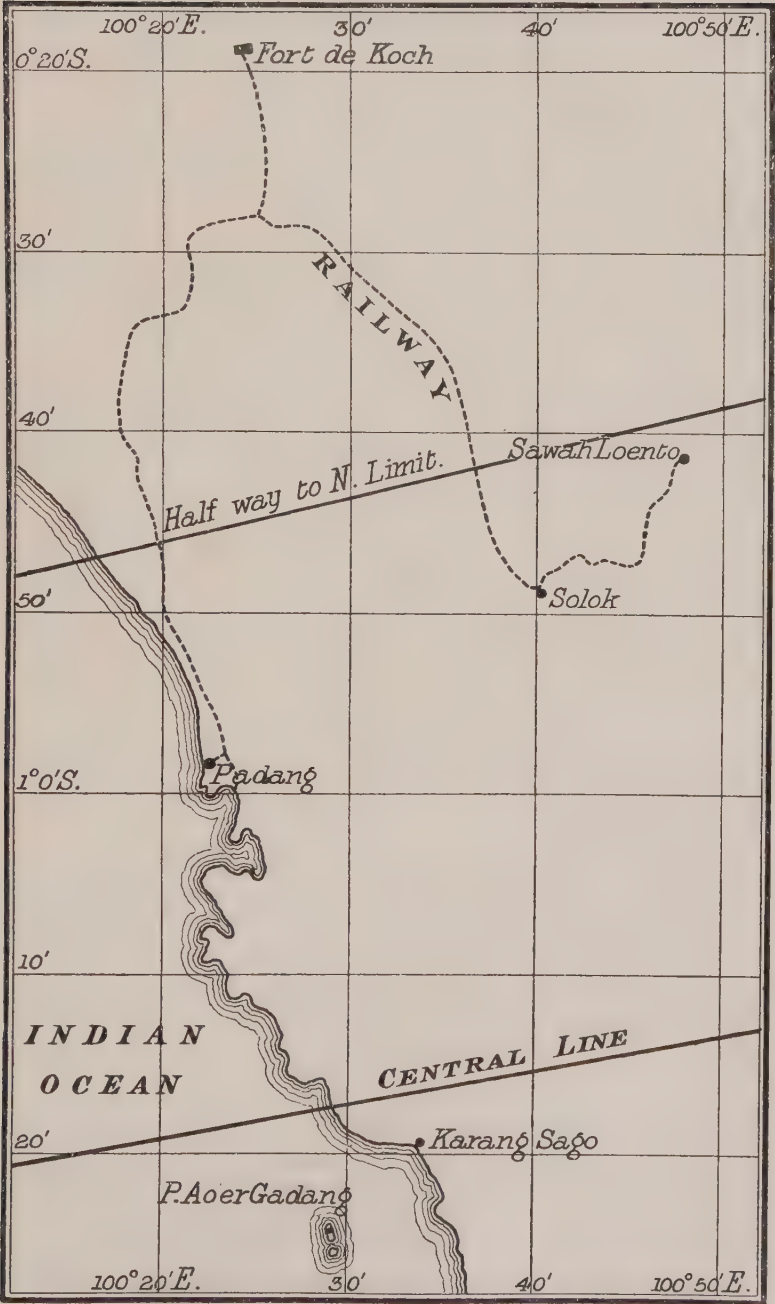
Padang, by the Lick Observatory party, French, Russian, and Japanese observers.

Karang Sago, by the Dutch party.

Aoer Gadang, by the Royal Observatory.

The presence of the "Pigmy" made it possible to occupy Aoer Gadang. This station had the advantage of being as far away as possible from the mountain range which runs parallel to the west coast of Sumatra. Solok and Sawah Loento are to the east of this range.

Aoer Gadang is a small island about 1 mile long and $\frac{1}{4}$ mile broad, surrounded by a coral reef. The site chosen for the eclipse camp was a small clearing near the eastern shore opposite a passage through the reef. Its position, as determined from large scale maps published by the Government of the Dutch East Indies, is lat. $1^{\circ} 23' 28''$ S., and long. $100^{\circ} 29' 13''$ E. of Greenwich. It is about 7 miles distant from



the central line, 6 miles distant from the camp of the Dutch observers at Karang Sago, and 30 miles from Padang.

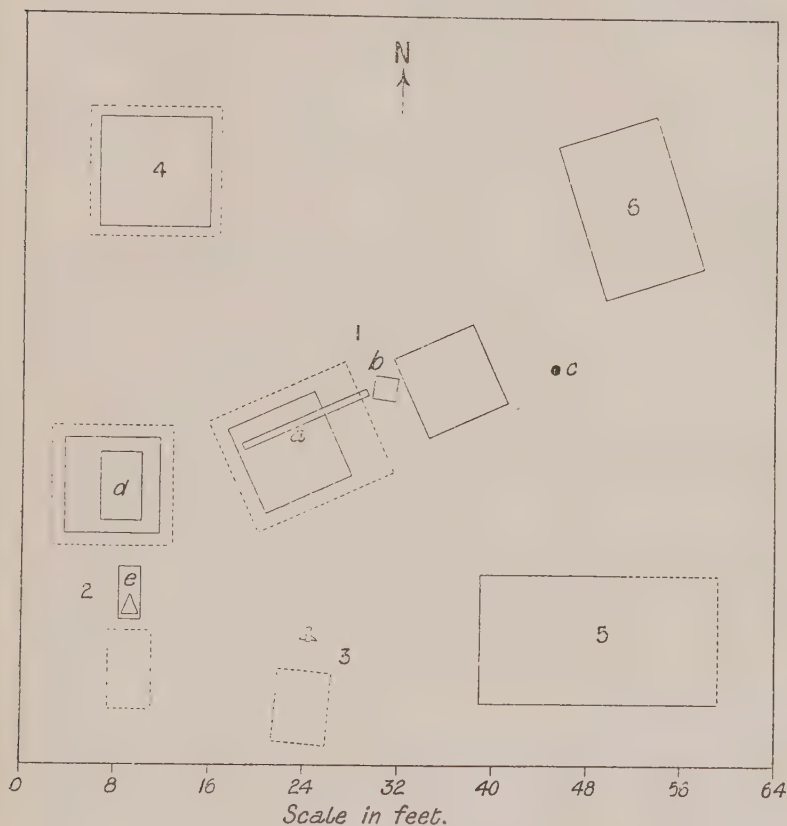
Erection of the Huts and Instruments.—The same light wooden frames covered with Willesden waterproof canvas which were used at Ovar in the eclipse of 1900, May 28, were taken out to Sumatra, with an additional one to serve as a developing room.* As a protection against sun and rain, these were supplemented by sheds, built in Malay style, of bamboos and thatched with *atap*, a species of palm leaf, which is obtained tied on laths about 4 feet long.

One open shed, 14 feet long and 12 feet broad, and 12 feet high at the gable, covered one of the two canvas huts and half of the second one, in which the Thompson coronagraph and the 16-inch cœlostat were placed. As at Ovar, the hut over the cœlostat was moved back a few feet during observations. Thatch was tacked on the roof of this hut. Similar sheds were fixed over the spectroscope hut and over the developing room. Thatch was also tacked all over the developing room hut. This, in addition to black waterproof paper inside, served to make the room light-tight. Movable sheds, each resting on four stout bamboos, were placed over the heliostat and condensing lenses of the spectroscopes and over the Dallmeyer photoheliograph. A house of bamboo and *atap* was also built, open on the east side and partly on the north, in which hammocks were swung, and where the observers lived at times when the "Pigmy" was obliged to leave for a short time. A tent was also erected for the two marines who were left on shore with the observers by Lieut. and Com. Oldham on such occasions. The general arrangement of the station is shown in the accompanying diagram. These huts, which were very satisfactory, were built under the superintendence of two Malay employés of Mr. Delprât, the Director of Railways.

The cœlostat was mounted on a concrete pier sunk about 18 inches into the ground, and rising 4 inches above it. The clock was screwed on to a box which was partly let into the ground, the weight being carried over a pulley on an iron bracket fixed on a palm-tree at a height of about 12 feet. The Thompson tube was mounted on boxes. The table of the spectroscope was placed on four brick piers 4 feet high. The heliostat and condensing lenses were placed on a heavy box which rested on two rows of bricks, which raised it about 4 inches above the ground, the bricks being fixed on a bed of concrete. A foundation of brick and concrete was also provided for the Dallmeyer photoheliograph. In the building of the foundations, erection of piers, and putting together of the canvas huts we received every assistance from the officers and men of the "Pigmy," and are specially indebted to Lieut. Briggs and the engineer, Mr. Townsend. The erection of the huts and instruments occupied us till the beginning of May.

* 'Roy. Soc. Proc.,' vol. 67, p. 393.

PLAN OF ECLIPSE STATION AT AOER GADANG, 1901 MAY 18.



1. { *a.* Thompson coronagraph.
b. Cœlostæt.
c. Palm-tree to which clock-weight was attached.
2. { *d.* Spectroscopes.
e. Heliostat.
3. Double photographic camera.
4. Developing room.
5. Observer's house.
6. Men's tent.

Personnel.—The following list gives the names of those who took part in the observations:—

F. W. Dyson—Quartz spectroscope, Thompson coronagraph.

J. J. Atkinson—Flint spectroscope.

Lieut. and Com. Oldham—Double camera for small-scale photographs. Observed duration.

Lieut. Frewen—Gave signals of beginning and end of totality. Observation of stars.

Engineer Townsend—Set heliostat for corona spectrum, and again for second contact.

Surgeon Nimmo—Exposed at object glass of Thompson coronagraph. Observed duration.

Seven men from the "Pigmy" also assisted; two counting seconds with the aid of a metronome; one exposing in front of the condensing lenses for the spectroscope; one exposing in front of the object glasses of the double camera; and three assisting in handing plate holders to Mr. Dyson and Captain Oldham.

The mode of procedure, which was carefully rehearsed on several occasions previously, was as follows: The observers were stationed at their instruments, and Lieut. Frewen watched the diminishing length of the crescent of the sun on the ground glass of the coronagraph. He had a paper scale on which the lengths of the crescent were marked, computed at intervals of 3^m, 2^m, 1^m, 30^s, 20^s, 10^s before totality. At 3^m before totality Mr. Frewen called out "Stand by," and the metronome, which had been carefully rated, was started. At 1^m before totality he called out "Get ready." At the words "Thirty seconds" Mr. Dyson and Mr. Atkinson drew out the dark slides ready for exposure. At the word "Ten" the exposures for the "flash" spectrum were begun. At the word "Now" given at the moment of totality the time was recorded by Lieut. Oldham and Dr. Nimmo. Six seconds after totality Mr. Dyson and Mr. Atkinson changed the plates of the spectra and exposed for the corona spectrum, Mr. Townsend moving the image on the slit by the heliostat. Mr. Dyson then went to the Thompson coronagraph and made exposures as detailed below, while Lieut. Oldham exposed with the double camera. When the exposures with the Thompson were finished, about 30^s before the end of totality, Mr. Dyson returned to the spectroscope, where he and Mr. Atkinson changed the plates ready for the second flash, and Lieut. Frewen returned to the ground glass of the coronagraph, calling out "Now" at the instant of re-appearance, the times being noted as before by Lieut. and Com. Oldham, and by Surgeon Nimmo.

The Day of the Eclipse.—From May 1 to May 13 the weather was very fine in the early mornings, but the sky became overcast later in the day. On some of these days the observing conditions at the time of the eclipse were excellent, and on all were moderately good. On May 13, however, there was a heavy thunderstorm, and till May 17 the sky was generally overcast about noon. May 17 was a very wet day, and on May 18, the day of the eclipse, it was completely overcast at 6^h. At 8^h it began to clear, but during totality there was a good deal of light cloud in front of the sun. At 1 o'clock the sky was perfectly clear.

The following readings of the dry-bulb thermometer were taken on the day of the eclipse:—

	Local time.			Reading of thermometer.
	hrs.	mins.	secs.	°
Beginning of eclipse	10	48	0	—
	11	0	0	88·8
	11	17	0	86·0
	11	30	0	85·0
	11	45	0	84·3
	12	0	0	81·8
	12	20	0	79·0
Beginning of totality	12	19	30	—
End of totality.....	12	26	50	—
	13	25	0	84·9
	13	40	0	84·9
	13	53	0	88·0
End of eclipse	13	58	0	—

As the temperature usually rose from 90° to 92° , there would seem to have been a fall of temperature of from 10° to 13° due to the eclipse.

The duration of the eclipse was observed by Captain Oldham as $6^m 20^s.5$, and by Dr. Nimmo as $6^m 21^s.5$. These times agree with those obtained by the Dutch observers at Karang Sago, who give for the duration $6^m 22^s$.* These times are 10^s less than that given in the Nautical Almanac, but agree closely with a prediction kindly forwarded by Dr. Downing (based on a value of $15^{\circ} 31' 47''$ for the mean semi-diameter of the Moon, derived from a recent discussion of eclipse observations), viz., $6^m 20^s$.

At the commencement of totality at Aoer Gadang a signal was flashed across to the Dutch eclipse camp by the "Pigmy" search-light, thus giving them a warning 16^s before totality occurred at their station.

During totality the sky was much darker than at Ovar in the eclipse of 1900, May 28. Venus, Mercury, and Aldebaran were seen. The corona appeared to be white; the polar plumes and the prominences were distinctly seen.

Development of the Photographs.—As stated in a previous paragraph, a fully equipped dark room was taken out to Sumatra. It was found before the eclipse that considerable care was needed in the development of photographs owing to the high temperature. Immediately after the eclipse the "Pigmy" went to Padang, returning the next day with 250 lbs. of ice. The photographs were developed on May 19 and five following nights. Thanks to the untiring assistance of Mr. Curtain, gunner of the "Pigmy," the development of the thirty-seven

* 'Proceedings of the Koninklijke Akademie van Wetenschappen te Amsterdam, 1901,' p. 87.

photographs, which was a somewhat trying and arduous matter, was carried out very satisfactorily, only one failure of any consequence occurring.

II. *Photographs of the Corona.*

The programme of observations was composed of two distinct parts:

(1.) Photographs of the corona on a large scale to show structural detail.

(2.) Photographs on a smaller scale with rapid lenses, to show the coronal streamers with the greatest possible extension, and to photograph the sky round the Sun for the detection of an intra-Mercurial planet, should one exist.

(1.) *Large-scale Photographs.*—The instrument used was the Thompson photographic telescope with object glass of 9 inches aperture and 8 feet 6 inches focal length, belonging to the Royal Observatory, in combination with a concave telephoto lens by Dallmeyer, of 4 inches aperture and 16 inches focus, fitted as a secondary magnifier, to give an image of the sun 4 inches in diameter, with a field (for full pencils) of 14 inches. The total length of the coronagraph was 12 feet, the equivalent focal length being about 36 feet. The focus was determined by the method used by the Astronomer Royal at the eclipses of 1896, 1898, and 1900, by means of the image of a gauze net in the plane of the plate reflected from the plane mirror of the cœlostat.* In the determination of the focus, which was done at night, Mr. Curtain, warrant officer, rendered great assistance. A cœlostat, with 16-inch plane mirror (made by Dr. Common), was employed to reflect the rays into the coronagraph, which pointed downwards to the mirror at an angle of 3° or 4° , and was in the azimuth 18° north of east on the day of the eclipse. The adjustment of the cœlostat was readily made by observations of the Sun with the attached theodolite in the usual manner.

The camera was furnished with eight plate holders, to take 15×15 inch plates, or for the shorter exposures 12×10 inch plates in a carrier.

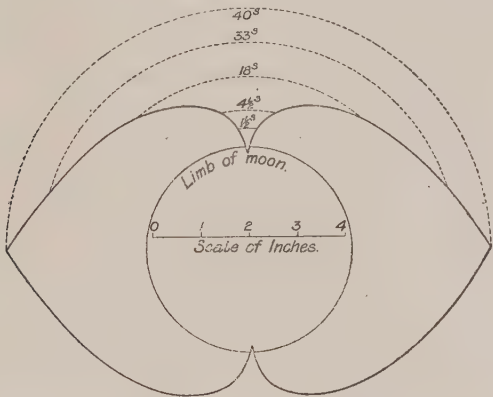
Two of the photographs were taken with a Burckhalter apparatus, made at the Royal Observatory, for graduating the length of exposure at different distances from the Sun's limb. For this purpose a zinc screen, whose form is shown in the diagram, and which was arranged to give what appeared to be suitable exposures at different distances (as shown by Professor Burckhalter's previous experience and Professor Turner's investigation of the diminution of the intensity of the coronal light) was rotated in front of the plate.

To accomplish this, photographic plates were obtained with a hole

* 'Monthly Notices, R.A.S.,' vol. 57, p. 105; 'Roy. Soc. Proc.,' vol. 64, vol. 67, p. 397.

in the centre $\frac{3}{4}$ inch in diameter, through which a spindle, mounted on the back of the plate carrier, was passed. On this spindle the screen was fixed in the dark room after the plate had been put in the carrier.

Occluding Shutter for Photographs of Corona by Burckhalter's Method.



The figures against the dotted lines show the effective exposures at different distances from the Sun's centre.

During the exposure, the observer turned a small handle about once a second, which, by a suitable train of wheels, caused the screen to turn about eight times a second. The apparatus appears to work perfectly smoothly, as the limb of the Moon is sharply defined on the photographs taken.

The eight slides were exposed as below, the exposures being made at the object glass by Dr. Nimmo :

	Exposure.			Plate.	in.
	Begin- ning.	End.	Dura- tion.		
	m. s.	m. s.	secs.		
1	0 30	0 40	10	Mawson Photo-mechanical.	12 × 10
2	1 0	1 10	10	Edwards' Ordinary.	12 × 10
3	1 20	1 40	20	Ilford Empress.	15 × 15
4	2 0	2 40	40	" "	15 × 15
5	2 50	3 30	40	Barnet Rocket.	15 × 15
6	3 40	3 45	5	Imperial Ordinary.	12 × 10
7	4 5	4 15	10	" Sovereign	15 × 15
8	4 35	4 55	20	Wratten and Wainwright Ordinary.	12 × 10

A ninth plate was taken at 1 o'clock, local time, on which two exposures were made (the driving clock being stopped for two minutes between) for determination of the orientation of the plates.

"Abney" squares were printed on No. 6 when the plates were put in their carriers the night before the eclipse. The exposure given was 15" to the light of a standard candle at the distance of 5 feet.

Of the eight photographs taken, the two by Burekhalter's method of an occulting shutter, are failures. The failure is not due to any fault in the method, but apparently is entirely owing to insufficient exposure, the corona photographed on the plates not extending as far as had been anticipated from previous eclipses. It seems probable that with a clearer sky these would have been quite satisfactory.

The other six photographs are excellent. The programme of exposures, which was carefully arranged with the Astronomer Royal before leaving England, has resulted in a well graduated series of photographs from No. 1, which shows the prominences and a small amount of corona to No. 5 in which the extension is shown to about 25' from the Moon's limb. The polar plumes and the coronal streamers are well brought out, as well as the remarkable detail of the inner corona. Two features call for special note: (1) the polar streamers round the Sun's north pole are not nearly so extensive as those round its south pole; (2) a very remarkable arch in the corona round the large prominence at position angle 145° (measuring N.E.S.W.). Round this prominence three separate arches are shown, one inside the other, their radii being 1'·2, 2'·4, and 3'·7 respectively. They have the appearance of layers of clouds over an eruption.

(2.) *Small-scale Photographs to show Extension of the Corona.*—The double camera was used in this eclipse exactly as at Ovar to carry a Dallmeyer rapid rectilinear lens of 4 inches aperture and 34 inches focus working at $f/8$ (lent by the Royal Astronomical Society), and a "Unar" lens, by Ross, of 2·4 inches aperture and 12 inches focus, working at $f/5$.

Eight plate-holders, each taking a pair of 16 cm. $\times$ 16 cm. plates, were used during totality. The exposures, to avoid any possibility of shake, were made by holding a cover in front of the object glasses.

The mounting was exactly as at Ovar.

The exposures were as follows:—

No.	Duration. secs.	Plate.
1	5	Wratten and Wainwright Instantaneous.
2	20	Ilford Empress.
3	10	Imperial Ordinary.
4	35	Imperial Special Rapid.
5	20	Imperial Ordinary.
6	35	Imperial Sovereign.
7	5	Wratten and Wainwright Instantaneous.
8	10	Imperial Ordinary.

Abney squares were printed on No. 6 by exposure to a standard candle at a distance of 5 feet for 4 minutes with the Dallmeyer lens, and 8 minutes with the Unar lens. It had been intended to print squares on several plates, but the number of photographs to be dealt with made it necessary to limit work as much as possible the night before the eclipse when the photographic plates were taken from sealed tins and put in their carriers, and after the eclipse it was necessary to finish the developing as soon as possible. Of these photographs Nos. 5, 6, 7, 8 are the most successful. The extension shown with the Abney lens reaches to 66' from the centre, and with the Unar lens to 77'.

Venus and Mercury and a number of stars are shown on the Unar plates. No. 5 is the best, and shows 7 stars of the Pleiades and 25 others of magnitudes ranging from 4 to 6, which have been identified. Unfortunately, owing to the clouds, stars are not equally well shown all over the plate, and δ Tauri (4^m.0) and θ Tauri (3^m.9) are not shown; γ Tauri (3^m.9), which is near θ Tauri, is, however, shown.

It may be concluded that any object appreciably brighter than 4^m.0 within the area covered by the plate (*i.e.* within 15° of the Sun) would have been shown.

III. The Spectroscopic Cameras.

The two spectroscopes used by Captain Hills at the Indian Eclipse of 1898 were kindly lent by him, and were used in Sumatra with the following adjustments:—

	Spectroscope No. 1.	Spectroscope No. 2.
Objective	Cooke, achromatic, 4½-in. aperture, 6-ft. 2¼-in. focus.	Single quartz lens, 5-in. aperture, 4-ft. 7-in. focus.
Collimator and camera lenses	Single quartz lens, 2½-in. aperture, 30-in. focus.	Single quartz lens, 3-in. aperture, 33½-in. focus.
Prisms	Two dense flint prisms of 60°, 4½-in. base, 2½-in. height.	Four double quartz prisms of 60° (each prism being composed of two half-prisms of right- and left-handed quartz), 3½-in. base, 2¾-in. height.
Slit.....	1½ in. by 0.0015 in.....	2 in. by 0.0012 in.
Prisms at maximum deviation for	H (λ 4340).....	λ 3500.

The width of the slit of the flint spectroscope was obtained by means of the diffraction images, and that of the quartz was checked in the same manner.

The length of the spectrum of the flint is 3¼ inches from H_{β}

(λ 4861) to K (λ 3934), and for the quartz 3 inches from λ 4000 to λ 3300. In order to obtain a greater length of spectrum in focus, the plate holders were made, at Mr. Davidson's suggestion, to carry two plates $3\frac{1}{4}$ inches wide, inclined at a suitable angle, instead of one $6\frac{1}{2}$ inches wide.

Both spectroscopes were mounted horizontally, and supplied with light by a heliostat furnished with a 12-inch flat mirror. The heliostat was adjusted in the usual manner by means of the attached theodolite.

Programme of Exposures.—The two spectroscopes were adjusted to be as nearly as possible on the Sun's limb simultaneously, and the programme of exposures was the same for both. The cameras were provided with rack movements so that a number of exposures could be made on the same plate. The programme arranged to take—

(i.) A number of short exposures from 10^s before to 6^s after the beginning of totality for the "flash" spectrum.

The plate carriers were then changed, and

(ii.) An exposure for the spectrum of the corona made from 15^m or 20^s after the beginning of totality, and continued for $5\frac{1}{2}$ minutes—the exposure ending at 5^m 50^s from the beginning of totality.

The plate carriers were again changed, and

(iii.) From 6^m 10^s from the beginning or 10^s from the end of totality, exposures were to be made for the "flash" at third contact.

Between (i) and (ii) the image of the Sun was to be brought by the slow motion of the heliostat from being nearly tangential to the slit to a position in which the horizontal diameter was divided by the slit in a ratio of 1 : 3. Again, between (ii) and (iii) it was to be brought nearly tangential.

A hitch occurred between (ii) and (iii), and the "flash" at second contact was not obtained.

The plates used for the "flash" at the beginning of totality were Edwards' Isochromatic and Ilford Empress for the flint spectroscope, and Ilford Empress for the quartz.

For the corona, "Snap-shot," Isochromatic, and Rocket plates were used for the flint spectroscope, and Imperial Special Rapid for the quartz.

The Corona Spectrum.—The continuous spectrum of the corona is shown from D_3 (λ 5876) to λ 3350. The green line at 5304 is strongly shown. The lines at 4568, 4233 and 3987 are shown. No new lines are shown. In the ultra-violet the lines at 3801, 3456 and 3381 are strongly shown, and possibly some fainter lines. The wave-lengths have not yet been determined accurately. No absorption lines are shown.

The Chromospheric Spectrum.—This is obtained on the different plates extending from D_3 (λ 5876) to a little beyond 3300. The photographs are not on the whole so good as those obtained at Ovar, but will serve

to supplement at the two ends of the spectrum, 70 lines being shown between $H\beta$ (λ 4861) and D_3 (λ 5876), and 100 between 3500 and 3296.

“Total Eclipse of the Sun, 1901 May 18. Preliminary Account of the Observations made at the Royal Alfred Observatory, Pamplemousses, Mauritius.” By E. WALTER MAUNDER, F.R.A.S. Received October 24,—Read at Joint Meeting of the Royal and Royal Astronomical Societies, October 31, 1901.

General Arrangements.

An expedition from the Royal Observatory to observe the Solar Eclipse of 1901 in the island of Mauritius having been sanctioned by the Admiralty, I was instructed by the Astronomer Royal to proceed to that island, there to act in concert with the Director of the Royal Alfred Observatory, Mr. T. F. Claxton, who had expressed his desire to co-operate in the observation of the eclipse. In accordance with a scheme approved by the Joint Permanent Eclipse Committee of the Royal and Royal Astronomical Societies, I took out with me two instruments belonging to the Royal Observatory, Greenwich, for photographing the corona; the one giving an image of the Moon 2·4 inches in diameter, and intended to secure the general structure of the corona, and the other giving an image 0·3 inch in diameter, and intended to secure the outer coronal streamers. The Joint Permanent Eclipse Committee lent for use in combination with these instruments two celostats, the one carrying a mirror of 16 inches diameter, the other one of 12 inches. A third mirror, one of 12 inches diameter, was kindly lent by Mr. Frank McClean, F.R.S. My equipment was completed by the generosity of Mr. John Evershed, F.R.A.S., who very kindly placed his prismatic camera of 2 inches aperture at the disposal of the Astronomer Royal for my use in the eclipse.

I was warmly welcomed in Mauritius by the Director of the Royal Alfred Observatory, Mr. T. F. Claxton, and by his Chief Assistant, Mr. A. Walter. Both identified themselves completely with me in my work, and helped me in every possible way. We therefore combined the instruments which I had brought out with those of the Observatory, and worked with them as though we formed but one party, and as if the instruments were all part of the same equipment.

I was also greatly indebted to Sir Charles Bruce, G.C.M.G., the Governor of the island, and to Sir Graham Bower, K.C.M.G., the officer administering the Government during the Governor's absence, for the ready hospitality which they extended to me. Through their action, also, my instruments were landed without Customs examina-

tion and were conveyed by rail, free of cost, up to Pamplemousses, and back again after the eclipse was over. Free passes on all the railways of the island were also issued to me, and to Mrs. Maunder, who had accompanied me with a special instrumental equipment of her own. The military authorities also rendered great assistance. Lieutenant-Colonel H. J. Lyster, R.G.A., gave permission to nine non-commissioned officers of the garrison, who had volunteered for the purpose, to come down to assist in the eclipse observations. Of these, five also helped in the unpacking and erection of the instruments, and one, Staff-Sergeant R. M. Smith, A.O.C., gave great assistance in the cleaning, repair, and rating of the several driving-clocks. The expedition was also indebted to the Hon. Hamilton Stein, who undertook the re-shipping of the instruments for the homeward voyage; to Mr. G. Ireland, who supplied tarpaulins for covering the skeleton huts erected to shelter the instruments; to Captain A. W. de Wilton, Inspector-General of Police, who sent constables to keep the Observatory grounds from intrusion on the morning of the eclipse, and to Mr. D. P. Garrioch, Superintendent of Inland Revenue, who arranged for the greater part of the provisioning of the eclipse party during their stay at the Observatory.

Itinerary.—The instruments for the Mauritius expedition were despatched from the Royal Observatory on March 6, with the exception of the prisms and object-glass of the prismatic camera lent by Mr. John Evershed, F.R.A.S., which I took to Marseilles with my personal baggage. The instruments were embarked at the Royal Albert Docks on the ss. "Bagdad" of the Messageries Maritimes line, and transhipped from that vessel to the ss. "Melbourne" of the same line at Marseilles. I left London on March 23, and proceeded overland through France to Marseilles. Owing to the great dock strike then prevailing at Marseilles, the ss. "Melbourne" was not able to leave until the evening of March 26. The delay was, however, made up for by greater speed on the voyage, and Mauritius was reached on April 20, as had been originally expected. The return voyage was unexpectedly delayed, as the Messageries line quarantined the island on account of the plague there, and the Union-Castle steamers having ceased to run to Mauritius, in consequence of the South African war, the British India line *via* Colombo was the sole remaining homeward route, and even on this line the steamers only ran once a month. It was not possible, therefore, to leave Mauritius again until July 12, when I embarked on the ss. "Warora"; reaching Colombo on July 22. Here I had to wait until July 25, when I left by the ss. "Mombassa," also of the British India line, and reached London August 25. The instruments left Mauritius in the ss. "Slingsby" on July 12, and were received at the Royal Observatory, Greenwich, on September 10.

Station.—The station occupied was the Royal Alfred Observatory,

Pamplemousses, in the low-lying plain which occupies the north of the island of Mauritius. This was about 15 miles to the N.W. of the central line, but as the eclipse was one of long duration, the distance from the central line made but little difference to the length of totality, and several important considerations led to its adoption. First of all, the probabilities of fine weather at the time of the morning when the eclipse would take place, appeared much greater for the low ground in the north of the island, than for the hills in the centre; an anticipation which the event fully justified; for whilst the total phase of the eclipse was observed under favourable conditions at Pamplemousses, it was entirely lost in cloud at Curepipe, on the central line on the high ground in the interior. Next, there were the great advantages offered by the Observatory itself of accurate determination of time, of a site the co-ordinates of which were known, of two instruments on permanent mountings, an equatorial and a photoheliograph, suitable for use in the eclipse, and of two efficient and well constructed dark-rooms for photography.

The observing station was therefore fixed in the Observatory grounds, in Lat. $20^{\circ} 5' 39''$ S. and Long. $3^{\text{h}} 50^{\text{m}} 12^{\text{s}}.6$ E. according to the "Nautical Almanac," on the authority of the late Dr. C. Meldrum, the former Director.

Erection and Arrangement of the Instruments.

The instruments were landed from the "Melbourne" at Port Louis, on April 23, and were conveyed by rail to Pamplemousses, and from thence by road to the Observatory, the same day. The next day they were unpacked, and the positions which they were to occupy were chosen.

The main building of the Observatory is rectangular in form, and nearly but not exactly orientated. Its front or north side is $76\frac{1}{2}$ feet in length, and its breadth is $58\frac{1}{2}$ feet. Opposite the north front and distant from it 160 feet, is the Magnetic Basement, a structure of which only the roof is above the ground, and which is 43 feet square. A broad lawn extends between the two buildings, and the instruments were erected for the most part at the west end of the lawn, so as to command as much of the eastern sky as possible. It was, however, found necessary to cut down a clump of trees on the eastern side of the lawn to a height of 16 feet in order to secure an uninterrupted view of first contact, which would take place when the sun was only 5° high, and this Mr. Claxton accordingly had done.

The instruments were mounted in two divisions. The first division consisted of the Mauritius photoheliograph, which was dismounted from its equatorial stand in a detached dome in the Observatory grounds, and of a rapid rectilinear lens by Dallmeyer, of 4 inches

aperture and 32 inches focal length. These two instruments were placed horizontally, the camera of the R.R. lens being placed immediately above the photoheliograph tube, and both were supplied with light by means of a 16-inch mirror mounted on a cœlostat. The second division consisted of the Greenwich coronagraph, and Mr. Evershed's prismatic camera. The coronagraph was mounted in a horizontal position, and the prismatic camera was fixed immediately above it, both instruments being supplied with light by a 12-inch mirror mounted on a cœlostat. Between the two a clock was mounted which rang an electric bell close to the camera end of the photoheliograph, and another close to the 12-inch cœlostat, at every tenth second during totality. The instruments were fixed upon boxes filled with stones, and to shelter them skeleton huts were formed, each consisting of three pairs of poles carrying a ridge-pole. Tarpaulins were then thrown over the ridge-pole, and pegged down to the ground. When any instrument needed to be used, one or more of the tarpaulins could be thrown up on the side upon which it was desired to observe. During the eclipse all the tarpaulins were entirely removed, except one fixed round the 10-second clock, which was left in order to shelter the pendulum from the wind.

The positions of the instruments relative to the Observatory buildings are shown in the accompanying plan, in which are also indicated the positions of Mrs. Maunder's instruments, which were also set up in the Observatory grounds.

The above arrangement of the instruments was finally completed by May 11 when the prismatic camera was mounted, one week before the eclipse.

Personnel.—The following list gives the names of those who took part in the observations:—

With the 16-inch cœlostat and its telescopes—

T. F. Claxton—Mauritius photoheliograph. Large-scale photographs of inner corona.

Bombardier A. J. Cox—Recorder to Mr. Claxton.

Bombardier C. A. Truman—Carried plate-holders for Mr. Claxton to and from dark-room during the partial phase.

Charles G. Garrioch—Changed the plates in the plate-holders during the partial phase.

T. A. Pope—Rapid rectilinear lens. Small-scale photographs to show extension.

E. G. Rowden—Exposed at the object-glasses of both the photoheliograph and the R.R. lens for Mr. Claxton and Mr. Pope.

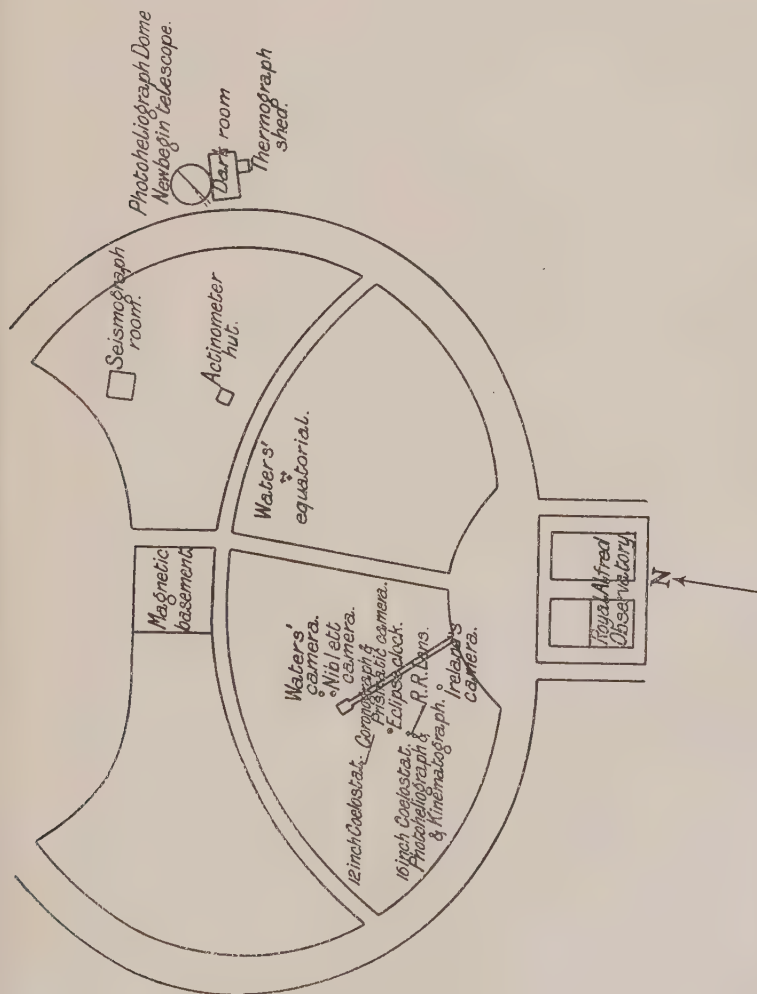
With the 12-inch cœlostat and its telescopes:—

E. Walter Maunder—Greenwich coronagraph. Large scale photographs of corona.

Lance-Corporal Lilley—Recorder to Mr. Maunder.

Bombardier W. Bailey—Moved rack-work of the Evershed prismatic camera.

Colour-Sergeant-Major W. Wade—Exposed at the object-glasses of both the coronagraph and the prismatic camera.



Plan of the Grounds of the Royal Alfred Observatory, Mauritius, showing the distribution of the Instruments during the Total Solar Eclipse of 1901, May 18.

With the 10-seconds eclipse clock :—

Staff-Sergeant R. M. Smith—Time-keeper at 10-second clock.

F. W. Robertson, Lieutenant, R.E.—Recorded times of the 10-second signal-bells.

With the 6-inch equatorial of the Mauritius Observatory :—

F. T. Piggott—Observed with the 6-inch equatorial.

N. V. Olivier—Recorder to Mr. Piggott.

The following was the method of procedure, which was carefully rehearsed many times on May 16 and 17. The observers took their places at their instruments, and Mr. Claxton watched the diminishing arc of the Sun on the ground glass of the photoheliograph, and at 30 seconds before second contact gave the word to "Stand by." At 20 seconds I gave the word to Sergeant-Major Wade to begin the exposure of the plates in the prismatic camera. At 10 seconds, when the arc of sunlight had lessened down to one of 49° , Mr. Claxton called "Ten," the signal to Staff-Sergeant Smith to start the 10-seconds striking eclipse clock, and Staff-Sergeant Smith called the number of the bells as they rang out at every tenth second from this moment until some time after third contact. The exposures at the different cameras were then made at the sound of the bells, and Lieutenant F. W. Robertson, R.E., entered the time of each bell as it rang; a very simple arrangement, which worked smoothly and well, and gave the times of exposure of the different plates very closely.

The Day of the Eclipse.—The weather at eclipse time—i.e., from $6^h 51^m$ to $9^h 5^m$ A.M.—had been by no means promising for the first three weeks after landing, but had tended to improve later. The morning of May 18 was the first upon which the Sun had been entirely free from cloud at the time of totality, $7^h 53^m$ A.M., and even on that morning first contact was lost by the interposition of a dense bank of cloud, which came up from the east soon after sunrise and overtook the Sun. It passed away in a few minutes, and the first photograph of the partial phase was taken at 16 minutes after the predicted time for first contact. Light scud continued to pass over the Sun for about 40 minutes more, but got thinner and lighter as totality drew on, and about $2\frac{1}{2}$ or 3 minutes before second contact the entire eastern half of the sky was free from cloud, and remained so until after fourth contact. But though the sky was thus apparently clear there was evidently much moisture in the air, since at Quatre Bornes, 13 miles to the south-west, the total phase was observed in a smart drizzle of fine rain; and at Curepipe, 16 miles to the south, it was entirely lost by thick cloud. The images also, as seen upon the ground glasses of the photoheliograph and coronagraph, were very unsteady, the Sun's limb "boiling" excessively. This "boiling" effect would seem to have been less noticeable in the 6-inch equatorial mounted in a dome on the roof of the Observatory main building, and in the Newbegin telescope brought by Mrs. Maunder and mounted in the photoheliograph dome of the Observatory, and which were therefore at a considerable elevation than in the instruments fed by the two

cœlostats which were necessarily quite close to the ground. The position of the latter, in the open air and placed horizontally, would render them more exposed to the effect of ground currents than the two other telescopes would be, pointing upwards at an angle of 19° and within domes.

The darkness during totality to the observers out in the open air was not great, the general illumination being considerably greater than at the full Moon. Five observers, noting the twilight illumination in the evening after the eclipse, considered it equal to that of mid-totality at the following local times:—

	h.	m.
Mrs. Claxton	5	58 P.M.
Mrs. Maunder	5	57
Mr. Claxton	5	58
Mr. Hall	5	58
Mr. Maunder	5	57

corresponding in the mean to 31 minutes after geometrical sunset, or to a position of the Sun, neglecting refraction, of $6^{\circ} 53'$ below the horizon.

But the observers in the equatorial and photoheliograph domes found it very dark during totality. A sudden gust of wind came from the N.E. at the moment of second contact and blew out the observer's candle in the equatorial dome. The recorder here, Mr. Olivier, found it quite impossible to read his chronometer or to write in the darkness, and hence Mr. Piggott's determination of the times of the second and third contacts were wholly lost.

Venus and Mercury were both very brilliant, side by side, some 5° below the Sun, whilst Jupiter and Saturn were prominent in the western sky. No search was made for other celestial objects.

Times of the Contacts.—The following determinations were made of the times of the three last contacts. As already stated, the first contact was lost through cloud:—

Observer	T. F. Claxton. R. Alfred Obs.	E. W. Maunder. R. Alfred Obs.	A. Walter. R. Alfred Obs.	Capt. Robertson. ss. "Ugina."
Place	Photoheliograph	Coronagraph.	Newbegin telesc.	Navy telescope.
Instrument	4 in.	4 in.	4½ in.	2 in.
Aperture	Kullberg 3400.	H. White 1424.	Webster 925	
Chronometer				
Error of chronometer	1 ^m 0 ^s 4 f.	3 ^h 53 ^m 47 ^s 3 s.	2 ^m 58 ^s s.	
Observed times—				
Second contact.	..	3 57 52.2	7 ^h 48 ^m 43 ^s	
Third contact..	..	4 1 25.1	7 52 15	
Fourth contact	9 ^h 5 ^m 43 ^s 0	5 10 55.1		
True local times—				
Second contact.	..	7 51 39.5	7 51 41	7 ^h 51 ^m 38 ^s
Third contact..	..	7 55 12.4	7 55 13	7 55 12
Fourth contact	9 4 42.6	9 4 42.4		

Captain Robertson was not present at the Royal Alfred Observatory, but observed the eclipse from the deck of his ship, ss. "Ugina," of the British India Steam Navigation Company, in Port Louis harbour, $6\frac{1}{2}$ miles S.W. by W. of the Observatory.

An accident prevented Mr. Claxton from observing the second and third contacts. Mr. Claxton and myself watched the contacts on the ground-glass screens of our respective cameras.

Times of the 10-second Bells.—The times of the 10-second bells of the eclipse clock—which was one of the clocks used by the late Sir G. B. Airy, K.C.B., in the Harton Colliery experiment—were recorded by Lieutenant F. W. Robertson, R.E., with the chronometer Kullberg 3400, that chronometer being $1^m 0^s.4$ fast.

No. of Bell.	Observed time.			True local time.		
	h.	m.	s.	h.	m.	s.
1	7	52	42.3	7	51	41.9
2			52.3			51.9
3		53	2.3		52	1.9
4			12.2			11.8
5			22.1			21.7
6			32.1			31.7
7			41.9			41.5
8			51.9			51.5
9		54	1.8		53	1.4
10			11.8			11.4
11			21.8			21.4
12			31.7			31.3
13			41.8			41.4
14			51.8			51.4
15		55	1.8		54	1.4
16			11.8			11.4
17			21.7			21.3
18			31.7			31.3
19			41.7			41.3
20			51.8			51.4
21		56	1.6		55	1.2
22			11.6			11.2
23			21.6			21.2
24			31.6			31.2

Staff-Sergeant R. M. Smith called out the numbers of the bells as each rang.

Photographs of the Corona.—These were taken on three different scales; the first on a scale of 8 inches to the Moon's diameter, to show the prominences and lowest corona; the second on a scale of 2.4 inches, to show the general structure of the corona; the third on a scale of 0.3 inch, to show the coronal streamers to the greatest possible extension. The aperture employed in each case was the same, viz., 4 inches, and the light-gathering powers on the plate of the three instruments were nearly in the proportion of 1, 11, and 700.

(1.) *Photographs on the 8-inch Scale.*

These were taken by Mr. T. F. Claxton with the photoheliograph of the Royal Alfred Observatory, Mauritius, the object-glass of which is 4 inches in aperture and 5 feet in focal length. It gives an image of the Sun nearly 8 inches in diameter, being fitted with a secondary magnifier, enlarging the image in the primary focus $13\frac{3}{4}$ times. The total length of the photoheliograph was $9\frac{1}{2}$ feet; its equivalent focal length 69 feet. The camera was constructed to carry plates 10 inches square, and it was proposed to expose six plates during totality for photographs of the corona, and as many as possible during the partial phase for determination of the Moon's place, and of the relative diameters of the Sun and Moon. Only three plates were exposed during totality, the handle of the shutter of the fourth plate-carrier breaking short off when the shutter was opened. The plate-carrier was thus locked in the camera, and it was not possible to release it until the total phase was over. The three plates taken were exposed as below, the exposures being given by Mr. Rowden at the object-glass of the instrument at the sound of the signal bells.

No.	From	To	Duration of exposure.	Plate.
1	Bell 3	Bell 5	sec. 20	Edwards' Medium.
2	" 6	" 8	20	Imperial Ordinary.
3	" 8	" 11	20	" Special Rapid.

After totality the clock of the *cœlost*at was stopped, and three photographs of the Sun were taken on the same plate for orientation. The true local times of the first and last of these were :—

h.	m.	s.
8	15	20·1
8	16	5·2

The time of the second exposure was not recorded. The plate was an "ordinary lantern" by Cadett and Neale. The aperture of the photoheliograph was reduced to $1\frac{1}{2}$ inches, and the exposure was given by the drop-slit in the primary focus.

Two sets of "Abney squares" were printed upon No. 3 on June 13, before the plate was developed. Both sets were printed by the light of a Sugg's Standard candle; the one being exposed for 4 seconds, the other for 64 seconds, the candle being at a distance of 10 feet in both cases.

The corona is seen only on the E. side of the Sun, as the image is

somewhat out of the centre of the plate in all three of the photographs; and owing partly to shake in the instrument, and partly to the excessive atmospheric disturbance, which under the high magnification employed was very apparent, the definition is poor in each case.

No. 1. The corona is shown to a height of about 1 minute of arc. The image is faint.

No. 2. The corona is shown to a height of about 3 minutes of arc. The image is fairly dense.

No. 3. The corona is shown to a height of about 2 minutes of arc. The image is faint and flat.

The Mauritius photoheliograph was focussed by repeated photographs of the Sun, taken during the fortnight preceding the eclipse.

(2.) *Photographs on the 2·4-inch Scale.*

These were taken with the object-glass of the Dallmeyer photoheliograph No. 5, belonging to the Royal Observatory, Greenwich—and which, like that of the Mauritius photoheliograph, had an aperture of 4 inches and a focal length of 5 feet—used in connection with a concave telephoto lens by Dallmeyer, of 3 inches aperture and 12 inches focal length. The instrument thus constructed has been referred to for convenience as the “Greenwich coronagraph,” and was about $7\frac{1}{2}$ feet in actual length, with an equivalent focal length of nearly 21 feet. It was furnished with ten plate-holders to take 12 by 10-inch plates, and it was proposed to take seven photographs during totality.

These photographs were taken by myself, Colour-Sergeant-Major Wade exposing at the object-glass of the instrument by the signal bells as follows:—

No.	From	To	Duration of exposure.	Plate.
			secs.	
1	Bell 2	Bell 3	10	Wratten and Wainwright Instantaneous.
2	” 4	” 6	20	Ilford Empress.
3	” 7	” 11	40	Imperial Special Rapid.
4	” 12	” 15	30	” Sovereign.
5	” 16	” 18	20	” Fine Grain Ordinary.
6	” 19	” 20	10	” Special Rapid.
7	” 21	—	4	” Ordinary.

After the ground glass had been inserted for the observation of third contact, and had been removed again, the aperture was diminished to half an inch, and the clock of the cœlostæt stopped and three photo-

graphs were taken of the Sun, on the same plate for orientation. The plate was an Imperial Fine Grain Ordinary and the exposure was as quick as could possibly be given by uncovering and covering the object-glass by hand. The true local times of the three exposures were:—

	h.	m.	s.
	7	58	39·3
	7	58	57·3
	7	59	17·3

A ninth plate, a Wratten and Wainwright Instantaneous plate, was exposed with the same aperture and exposure at 8^h 0^m 17^s·3. The plate in the tenth plate-holder was not used.

Two sets of "Abney squares" were printed upon No. 4 on June 13, before the plate was developed. Both sets were printed by the light of a Sugg's Standard candle, at 5 feet distance; the one being exposed for 15 seconds, and the other for 4 minutes.

No. 1 is a clean and fairly dense negative, showing well the polar rays and the structure of the lower corona, especially in the east equatorial wing. The west wing shows less detail. The corona is traceable to a distance of 15 or 16 minutes from the limb of the Moon in the S.E. ray.

No. 2 is a clear thin negative showing much about the same detail as No. 1.

No. 3 is a thin negative but shows a considerable extension of the great S.E. and N.E. rays and a good deal of detail in their lower regions.

No. 4 is a dense negative showing the greatest degree of extension in the coronal streamers of any of the series. In the case of the two chief rays, the corona can be traced to a distance of nearly half a degree from the Moon's limb.

No. 5 shows the lower corona well up to 5 or 6 minutes from the Moon's limb.

No. 6 is partly spoiled by fog, and only the lower corona is seen up to about 3 minutes.

No. 7 is a faint and delicate negative showing the chromosphere, prominences, and the lower corona up to a distance of about 3 minutes from the limb of the Moon.

Two methods were employed to focus the Greenwich coronagraph; the first being the method described by the Astronomer Royal in his Reports of the Eclipse Expeditions of 1896, 1898, and 1900,* an image of an object (gauze net in the plane of the plate) being photographed by reflection normally from the plane mirror of the celostat. The second method was by photographing Arcturus, the image of which was allowed to trail across the plate.

* 'Roy. Soc. Proc.' vol. 64, p. 8; and 'Monthly Notices, R.A.S.' vol. 57, p. 105, and vol. 60, p. 397.

(3.) *Photographs on the 0.3-inch Scale.*

These were taken by Professor T. A. Pope, of the Royal College, Mauritius, with a Dallmeyer rapid rectilinear lens of 4 inches aperture, and 32 inches focal length, Mr. E. G. Rowden exposing at the object-glass at the same time as he exposed for the Mauritius photoheliograph, which was mounted immediately below it. Six plate-carriers were provided for this instrument, and six photographs of the corona were secured.

No.	From	To	Duration of exposure.	Plate.
1	Bell 3	Bell 5	sec. 20	Imperial Process.
2	" 6	" 8	20	" Ordinary.
3	" 9	" 11	20	" Special Rapid.
4	" 12	" 14	20	Ilford Empress.
5	" 15	" 17	20	Wratten and Wainwright Instantaneous.
6	" 18	" 20	20	Imperial Fine Grain Ordinary.

The plates used were 16 cm. square, and the Sun was placed a little to the west of the centre of the field, so that Venus and Mercury might be included in the photographs. As they are well shown on all the plates, there was no need for any other mode of orientation, and no special photographs were taken for that purpose. Nor were the "Abney squares" printed on any of the plates with this instrument.

No. 1. A good clear negative. On the west side of the corona four straight rays are seen, the two longest extending about $1\frac{1}{4}^{\circ}$ from the Moon's limb. On the east two chief rays are seen, forming the edges of the great east equatorial wing of the corona. A fainter ray runs nearly parallel to the great N.E. ray. The rays on the E. are traceable to about 1° from the Moon's limb.

No. 2. Neither so dense nor so clear as No. 1, nor can the rays be traced quite so far upon it.

No. 3. The sky glare has come up on this plate, which in consequence shows less than Nos. 1 and 2.

No. 4. Definition poor.

No. 5. Definition poor.

No. 6. Very dense image; the rays on the west can be traced to more than 2° from the Moon's limb.

The Dallmeyer R.R. lens was focussed by repeated photographs of star fields, especially of the field of the Southern Cross.

Development of the Photographs.—Owing to my having been taken ill on May 21 with a severe attack of malarial fever, the work of

developing the photographs was almost entirely carried out by Mr. Walter and by Mrs. Maunder, to whom the expedition is therefore greatly indebted for the results obtained. The weather being hot and damp, much difficulty was experienced with the different plates tested by way of experiment before the day of the eclipse. Finally the following developer was adopted and found to work well. In spite of its excessive dilution, it was found that fog resulted if its strength was materially increased.

Solution A.

Metol	40 grains.
Hydroquinone	50 „
Sulphite of soda	120 „
Bromide potassium	15 „
Water	20 ounces.

Solution B.

Caustic soda	100 grains.
Water	20 ounces.

For development half an ounce was taken of each stock solution and made up with water to 30 ounces, 15 drops of a 10 per cent. solution of bromide of potassium being added. During development this solution was strengthened by the gradual addition to it of a solution composed of 1 ounce of each of the two stock solutions made up with water to 10 ounces. But the stronger solution was seldom added to the weaker in a greater proportion than 1 to 15. The average time of development was 75 minutes.

Photographs of the Partial Phase.—These were taken with the photo-heliograph of the Royal Alfred Observatory, Mauritius, already described. The aperture for this purpose was reduced to $1\frac{1}{2}$ inches, and the exposure given by the drop-slit in the primary focus. Mr. T. F. Claxton made the exposures, and called the times by Kullberg 3400 to Bombardier Cox, who entered them. There being only three plate-carriers available for this work, Mr. C. Garrioch remained in the dark room to change the plates, and Bombardier Truman ran to and fro with them. The plates used were Cadett and Neale's ordinary lantern plates. The times of exposure were as follows:—

Before Totality.

No.	Observed times.			True local times.		
	h.	m.	s.	h.	m.	s.
1	7	8	19.8	7	7	19.4
2	7	10	19.8	7	9	19.4
3	7	14	5.3	7	13	4.9
4	7	18	1.3	7	17	0.9
5	7	22	46.3	7	21	45.9
6	7	28	47.3	7	27	46.9
7	7	31	7.8	7	30	7.4
8	7	35	6.2	7	34	5.8
9	7	38	47.3	7	37	46.9
10	7	42	43.0	7	41	42.6
11	7	44	32.4	7	43	32.0

After Totality.

12	8	2	48.8	8	1	48.4
13	8	3	43.3	8	2	42.9
14	8	11	44.5	8	10	44.1
15	8	12	41.0	8	11	40.6

Plate 16 had three exposures made upon it, the clock of the cœlostæt being stopped in order to give the means for determining the orientation of the plates.

No.	Observed times.			True local times.		
	h.	m.	s.	h.	m.	s.
17	8	19	40.0	8	18	39.6
18	8	22	34.3	8	21	33.9
19	8	24	25.7	8	23	25.3
20	8	26	44.3	8	25	43.9
21	8	31	28.6	8	30	28.2
22	8	32	33.2	8	31	32.8
23	8	34	40.5	8	33	40.1
24	8	36	24.5	8	35	24.1
25	8	39	56.3	8	38	55.9
26	8	42	7.5	8	41	7.1
27	8	45	13.2	8	44	12.8
28	8	48	15.4	8	47	15.0
29	8	50	33.7	8	49	33.3
30	8	53	8.2	8	52	7.8
31	8	54	5.0	8	53	4.6
32	8	59	50.2	8	58	49.8

The Director of the Royal Alfred Observatory has presented to the Astronomer Royal the photographs of the eclipse which he took with

the Observatory photoheliograph, both the photographs which he took of the corona during totality and the above photographs of the partial phase. The former I myself brought home to the Royal Observatory, Greenwich; the latter will be sent at the first available opportunity.

I took no observations myself of temperature during the eclipse, the Director of the Royal Alfred Observatory having made arrangements for full meteorological observations being taken both at the Observatory and at several other stations, not only in Mauritius, but also on other islands in the Indian Ocean.

“Preliminary Note on Observations of the Total Solar Eclipse of 1901 May 18, made at Pamplémousses, Mauritius.” By (Mrs.) A. S. D. MAUNDER. Received October 23,—Read at Joint Meeting of the Royal and Royal Astronomical Societies, October 31, 1901.

Having observed successfully the eclipses of 1898 January 22, in India, and 1900 May 28, in Algiers, and my husband having been sent to Mauritius as the representative of the Royal Observatory, Greenwich, to observe the eclipse of May 18 last, I determined to accompany him, and to take with me the instruments which we had used in 1900. By the great kindness of Mr. G. J. Newbegin, F.R.A.S., I was also furnished with a $4\frac{1}{4}$ -inch Cooke photo-visual telescope of 71 inches focus.

As my husband fixed his observing station at the Royal Alfred Observatory, Pamplémousses, and as the Director, Mr. Claxton, gave me every facility, I set up my instruments in the Observatory grounds. The Newbegin telescope was mounted upon the equatorial stand of the photoheliograph which was left vacant, the Mauritius photoheliograph having been dismantled in order that it might be used in connection with the 16-inch coelostat of the official Greenwich Expedition. The photoheliograph dome stands on the east of the Observatory grounds, and about 150 feet to the west of the dome I set up the Waters equatorial lent to my husband by the Royal Astronomical Society, which I used to carry two little cameras, each with a $1\frac{1}{2}$ -inch Dallmeyer Stigmatic lens. About 105 feet further west the camera belonging to the Waters telescope was firmly fixed, pointing directly to the Sun, and by its side the Niblett lens belonging to the British Astronomical Association, a photographic lens 4 inches in diameter, and of 34 inches focus. This was likewise fixed rigidly. Mr. Nevil Maskelyne, F.R.A.S., also lent me his kinematograph, and this was mounted a few feet further south. The management of these instruments during the eclipse was very kindly undertaken by several friends, and I was

further helped by three non-commissioned officers who had volunteered to assist in the eclipse observations. The entire party was arranged as follows:—

Personnel.

Mr. A. Walter : Newbegin photo-visual telescope, 71 inches focus.

Bombadier A. H. Thorne : Recorder to Mr. Walter.

Mrs. Walter Maunder : Dallmeyer Stigmatic lens twin camera, 9 inches focus.

Sergeant J. H. Tyson : Recorder to Mrs. Maunder.

Lance-Corporal A. Balguè : Waters camera, 8 feet equivalent focus.

Mr. G. H. Ireland : Kinematograph. The kinematograph gave no result, the film tearing across before totality was reached.

(Mr. Ireland brought a camera of about 2 feet focus, which was mounted as a stationary camera, and six exposures were made with it by Mr. T. W. Hanning.)

I add here a brief description of the photographs obtained :

1. *The Dallmeyer Stigmatic Twin Camera.*

These lenses are each $1\frac{1}{2}$ inches aperture, 9 inches focus, and give a field nearly 40° in diameter on a plate 16 cm. square. I procured one of these lenses in 1897, on account of its great field, in order to photograph the Milky Way, and it being the only photographic lens I then possessed, I took it to India in 1898. Exposures of 20 seconds made with it upon the corona of that year, recorded the coronal extensions much further from the Sun than they had been photographed before; in one instance to a distance of 13.9 lunar radii from the Sun's centre. My purpose on this occasion was to repeat the Indian exposures of 20 seconds, and also to try the effect of exposures longer still. I therefore gave two exposures with each camera—one of 2 minutes and one of 20 seconds.

No. 1.—From 30 seconds to 150 seconds. Exposure 120 seconds.
Sandell Triple-coated plate.

A fairly dense negative. The chromosphere has come up as a very brilliant ring, but the motion of the Moon across the Sun's disc during the very considerable exposure is very apparent. Of course no detail of the inner corona is seen on such a small image, except the large prominence on the east limb of the Sun, but the outer corona is fairly defined, tapering in long rod-like rays which on the east side of the corona reach a distance from the Sun of about five lunar radii, and on the west side of about six.

No. 2.—From 30 seconds to 150 seconds. Exposure 120 seconds.
Imperial Special Rapid plate.

This negative is not so dense nor so well defined as No. 1. The

sky glare has come up, and the extensions are not so considerable as in the former case.

No. 3.—From 170 seconds to 190 seconds. Exposure 20 seconds.
Sandell Triple-coated plate.

The image of the corona is fairly dense, but the sky glare has not come up so much as in the previous cases, and it shows as great extension as No. 1.

No. 4.—From 170 seconds to 190 seconds. Exposure 20 seconds.
Imperial Special Rapid plate.

This is a weak image, and has no points to recommend it.

(Nos. 3 and 4 have a double image on them, due probably to the cameras not having settled down after the plate-carriers were changed.)

2. *The Niblett Lens.*

This lens is of 4 inches aperture and 34 inches focus, fitted with a revolving drum carrying 5-inch by 4-inch plates.

No. 1.—Exposed at second contact. Exposure about $\frac{1}{4}$ second.
Imperial Fine Grain plate.

This photograph was taken at second contact, and several "beads" of sunlight are seen. Nevertheless, not only is there a great deal of detail to be seen in the middle corona, but on the west side a coronal ray can be traced to two lunar radii, and on the east side to a somewhat greater distance. The image is a fairly dense one. The image is not large enough, nor was the exposure sufficiently short to show any detail in the prominences or chromosphere, but the polar rays and the "combing out" of the equatorial wings are well seen.

No. 2.—Exposed at 40 seconds. Exposure about $\frac{1}{4}$ second. Imperial Ordinary plate.

A fairly dense image, showing the polar rays and middle corona well.

No. 3.—Exposed at 80 seconds. Exposure about $\frac{1}{4}$ second. Imperial Special Rapid plate.

The image is not so dense as in the previous cases, but the coronal rays can be traced to a greater distance, as can also the polar rays.

No. 4.—Exposed at 120 seconds. Exposure about $\frac{1}{4}$ second.
Imperial Special Rapid plate.

A weak faint image, under-developed. No detail shown.

No. 5.—Exposed at 160 seconds. Exposure about $\frac{1}{4}$ second.
Imperial Ordinary plate.

Under developed, only the chromospheric ring seen.

No. 6.—Exposed at 200 seconds. Exposure about $\frac{1}{4}$ second.
Imperial Fine Grain plate.

A good image, not very dense, showing the middle corona and polar rays well.

3. *The Newbegin Telescope.*

This lens is a Cooke photo-visual objective of $4\frac{1}{4}$ inches aperture and 71 inches focus. The photographs were taken on quarter plates. They form an exceedingly fine series of fourteen, taken on different makes of plate and with differing exposures. They bear magnification well up to the limit we have yet tried, namely, to one giving 4 inches to the Sun's diameter. Every photograph in this series was successful.

No. 1.—Exposed 7 seconds after commencement of totality.
Exposure instantaneous. Plate, Lumière Orthochromatic,
Series A.

This is a not very dense negative, and shows the prominences on the east side of the Sun, and the very complicated structure of the corona surrounding them. From the large prominence on the Sun's east equatorial limb two very marked and irregular black rifts or streaks cross the coronal wing and seem to broaden as they get further away from the Sun. A similar single streak leaves the Sun's surface to the south of the large prominence in the south-east.

No. 2.—Exposed at 21 seconds after commencement of totality.
Exposure, 2 seconds. Plate, Imperial Fine Grain Ordinary.

A denser negative than No. 1, showing great extension of the polar rays. In the northern polar rays is seen a forked dark marking cutting the rays obliquely.

No. 3.—Exposed at 32 seconds after the commencement of totality.
Exposure 4 seconds. Plate, Imperial Fine Grain Ordinary.

The dark marking in the north polar rays is clearly seen. There is a greater extension on the north-western side of the corona than in the two previous photographs.

No. 4.—Exposed at 45 seconds after commencement of totality.
Exposure 6 seconds. Plate, Imperial Fine Grain Ordinary.

The corona is distinctly larger than on the previous photographs, and the dark marking cutting the north polar rays is very clearly seen.

No. 5.—Exposed 1 minute after commencement of totality. Exposure 8 seconds. Plate, Imperial Fine Grain Ordinary.

A negative very similar to No. 4.

No. 6.—Exposed at 77 seconds after commencement of totality. Exposure 10 seconds. Plate, Imperial Fine Grain Ordinary.

No. 7.—Exposed at 94 seconds after totality. Exposure 6 seconds. Plate, Imperial Ordinary.

This negative is perhaps not so well defined as the others.

No. 8.—Exposed at 107 seconds after totality. Exposure 6 seconds. Plate, Imperial Ordinary.

This negative is not very dense, but the corona is very large, and it shows a greater extension of the coronal rays than any of the previous ones.

No. 9.—Exposed at 126 seconds after totality. Exposure 10 seconds. Plate, Imperial Fine Grain Ordinary.

No. 10.—Exposed at 144 seconds after totality. Exposure 8 seconds. Plate, Imperial Fine Grain Ordinary.

No. 11.—Exposed at 162 seconds after totality. Exposure 6 seconds. Plate, Imperial Fine Grain Ordinary.

On this negative it is very clearly seen that the bulbous curves at the base of the great north-east wing are laid over and across other coronal curves in the background.

No. 12.—Exposed at 176 seconds after totality. Exposure 4 seconds. Plate, Imperial Fine Grain Ordinary.

This photograph shows perhaps best the corona in the south-west region. Here there seem to be a number of synclinal groups, which give the impression of not being all in the plane of the photograph, as usually appears to be the case in coronal negatives, but in different planes.

No. 13.—Exposed at 191 seconds after totality. Exposure 2 seconds. Plate, Imperial Fine Grain Ordinary.

The corona is here very restricted. In the south-west region the exposure does not seem to have been sufficient to bring up all the synclinal groups, and in consequence the south polar rays have the appearance of encroaching on this side.

No. 14.—Exposed at 202 seconds after the commencement of totality. Exposure instantaneous. Plate, Lumière Orthochromatic, Series A.

This negative is fainter than any of the others, but shows well the detail and prominence in the south-west region of the corona.

4. *The Waters Camera.*

This is a Dallmeyer portrait combination of 2 inches aperture and 8 feet equivalent focus, a Dallmeyer telephoto lens being used as a negative enlarger. The photographs were taken on half plates. The enlargement is rather too great for detail of any importance to be shown, and there is therefore no need to describe them in detail. Exposures of about a quarter of a second were given in all cases.

- No. 1.—Exposed at second contact. Plate, Imperial Special Rapid.
- No. 2.—Exposed at 40 seconds. Plate, Imperial Special Rapid.
- No. 3.—Exposed at 80 seconds. Plate, Imperial Flashlight.
- No. 4.—Exposed at 120 seconds. Plate, Imperial Flashlight.
- No. 5.—Exposed at 160 seconds. Plate, Imperial Flashlight.
- No. 6.—Exposed at 200 seconds. Plate, Imperial Special Rapid.

5. *The Pinhole Camera.*

This was a camera with pinhole aperture of $\frac{1}{32}$ of an inch, and the plate was placed at a distance of 30 inches. The plate was exposed immediately before second contact, and closed immediately after third. A small arc of sunlight is thus seen both on the east and west limbs of the Moon. A coronal ring, about 4 minutes in greatest height, is seen connecting these arcs. The little photograph has of course no scientific value, but as being the only instance of a photograph of the corona taken with a pinhole, it may rank as a curiosity. The ratio of aperture to focal length was as 1 to 960, and the exposure given to the plate would correspond to one of $\frac{1}{15}$ th of a second, as given with the Newbegin. The plate used was an Imperial Special Rapid.

6. *Photographs of the Landscape.*

At my request M. Alexander Rambert, a professional photographer of Mauritius, took a series of photographs of the landscape during the coming on and passing off of the shadow. The same exposure was given in every instance, the plates were all from the same batch, and they were developed at one and the same time, in the same bath and for the same length of time. The exposures were made at regular intervals of 5 minutes, the first being taken $27\frac{1}{2}$ minutes before mid-totality, the last $27\frac{1}{2}$ minutes after. A comparison of the plates taken before totality with those taken at corresponding times after, shows a slight but appreciable increase in density in the later plates as compared with the earlier, but perhaps not more than would be accounted for by the increase in altitude of the Sun.

LONDON:

HARRISON AND SONS, PRINTERS IN ORDINARY TO HIS MAJESTY,
ST. MARTIN'S LANE

MONTHLY NOTICES
OF THE
ROYAL ASTRONOMICAL SOCIETY.

APPENDIX TO VOL. LXII.

[*From Proceedings of the Royal Society, Vols. LXIX and LXX.*]

With indication of the original pagination.

No. 2.

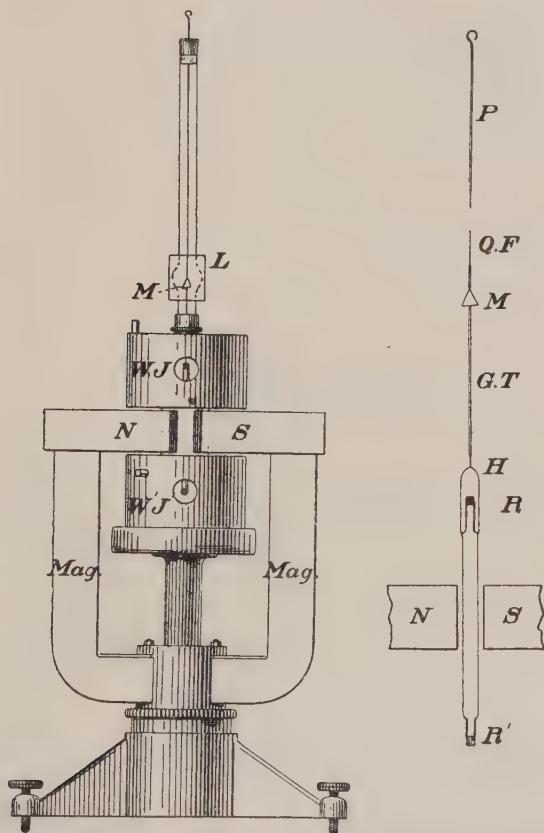
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“The Effective Temperature of the Sun.” By W. E. WILSON, D.Sc., F.R.S. Received December 5,—Read December 12, 1901.

In March, 1894, Dr. G. Johnstone Stoney communicated to the Society a memoir by myself and Mr. P. L. Gray, entitled “Experimental Investigations on the Effective Temperature of the Sun,” which was published in the ‘Phil. Trans.,’ A, vol. 185 (1894). In these investigations the method we adopted was as follows:—A beam of sunlight was sent horizontally into the laboratory by means of a Stoney single-mirror heliostat. The mirror was an optical plane of unsilvered glass, and the beam was directed into one aperture (A) of a differential Boys’ radio-micrometer. The other aperture (B) received the radiation from a strip of platinum, which could be raised to any desired temperature by an electric current supplied by a battery of accumulators. The temperature of this strip was at any moment determined by its linear expansion, the instrument being previously calibrated by melting on it minute fragments of AgCl and of pure gold, as in Joly’s melderometer. In front of the aperture (B) of the radio-micrometer was placed a stop with a circular hole of 5.57 mm., and the distance of this hole from the receiving surface of the thermo-couple was 60.2 mm. This gave for the angle subtended by a diameter of the aperture at the receiving surface $5^{\circ}301$. Knowing then (i) the ratio which the angular diameter of this circular aperture bears to that of the sun, (ii) the temperature of the platinum strip at the moment that the radio-micrometer is balanced, (iii) the amount of the sun’s radiation lost by reflection from the heliostat mirror and also by absorption in the earth’s atmosphere, it is possible on any assumption with regard to the law connecting radiation with temperature, to determine the effective temperature of the sun. A series of very accordant observations were made in this way, the mean of which gave 6200° C. as the effective solar temperature.

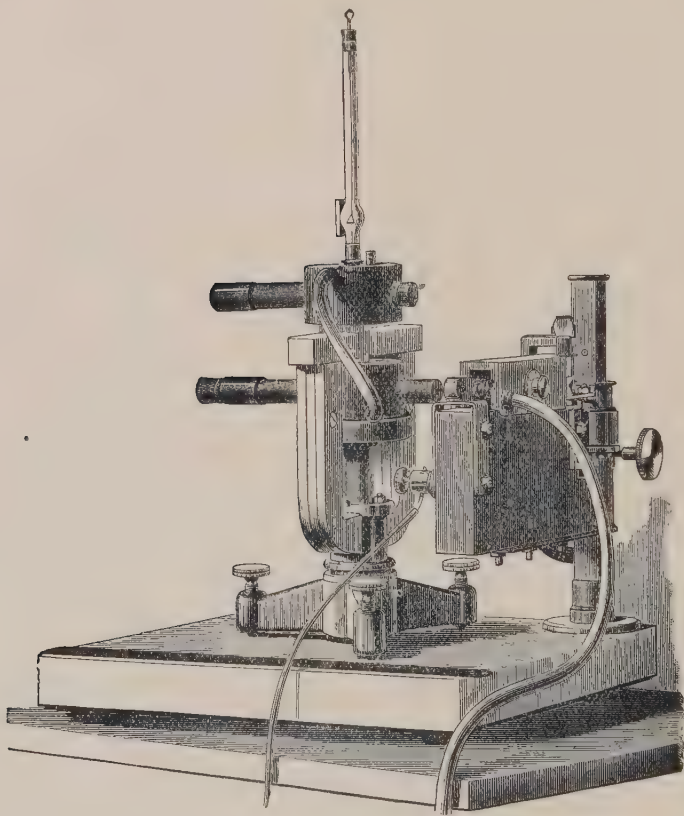
For the details of the apparatus and the complete method of reduction of the observations, the original memoir in the 'Phil. Trans.' may be referred to.



In order to protect the incandescent strip from draughts of air it was covered with a water-jacket of gilded brass. This was provided with a circular hole in one of its longer sides, through which its radiation could reach the aperture of the radio-micrometer. The internal walls of this water-jacket being highly polished, it has occurred to me, since the publication of the memoir referred to, that possibly some of the radiation from distant parts of the platinum strip may have been reflected backwards and forwards from the polished walls and the strip itself, ultimately escaping through the aperture and reaching the radio-micrometer, thus increasing the amount of radiation which should have reached it directly from the strip alone.

In order to test this surmise I first took a number of readings at known temperatures with the walls of the water-jacket polished as

before. I next smoked the surface of the walls well, and found that the amount of radiation coming from the aperture was then sensibly reduced. It is also possible that changes in the condition of the surface of the platinum strip may effect its emissivity, and in fact it is very doubtful whether it is possible to determine with any degree of accuracy what the emissivity of bright platinum is, relatively to lamp



black. In the original memoir we took Rosetti's estimate of 35 per cent. as the most probable value for this quantity, but as our former estimate of the solar temperature depends greatly on this factor, to which so much uncertainty attaches, I thought it would be a distinct advance to abolish entirely the platinum strip as a source of radiation, and to substitute in its place a uniformly heated enclosure which would radiate as an absolutely "black body."

In 1895 Mr. Lanchester pointed out to me that such an enclosure would be a theoretically perfect radiator; while Lummer, Paschen and others have shown that the law connecting temperature and

radiation from such an enclosure confirms in a remarkable manner Stefan's law of radiation, viz., $R = aT^4$.* Since therefore the results of several independent investigations corroborate this law, I have felt justified in applying it to the results of my observations.

On consideration it seemed that the most convenient form of radiator would be a long tube closed at one end, and uniformly heated in a gas furnace. Accordingly a porcelain tube, 2 feet in length and 1 inch internal diameter, was fitted into a Fletcher gas-tube furnace. This was afterwards changed for an iron tube, which was employed in the observations on September 30th, given below.

A plug of asbestos was inserted in the tube at about 10 inches from the end farthest from the radio-micrometer, and resting against this plug was the end of a Callendar platinum-resistance thermometer. This was connected with one of Professor Callendar's electric recorders, so that during an experiment the temperature of the tube was registered continuously on the paper wrapped round the drum of the instrument. In front of the open end of the tube, and between it and the radio-micrometer, was placed a large brass water-screen, through which a copious supply of water passed. In front of the aperture (B) of the radio-micrometer this screen was provided with a rectangular aperture. One side of this aperture was formed by a slide moved by a micrometer screw reading to 0.01 mm. By this means the area of this aperture at any time could be measured with precision. Its fixed sides were 5 mm. apart, and as the movable side had a range of 5 mm., the maximum area of the aperture was 25 sq. mm. The distance (d) of this aperture from the surface of the thermo couple was 66.3 mm.

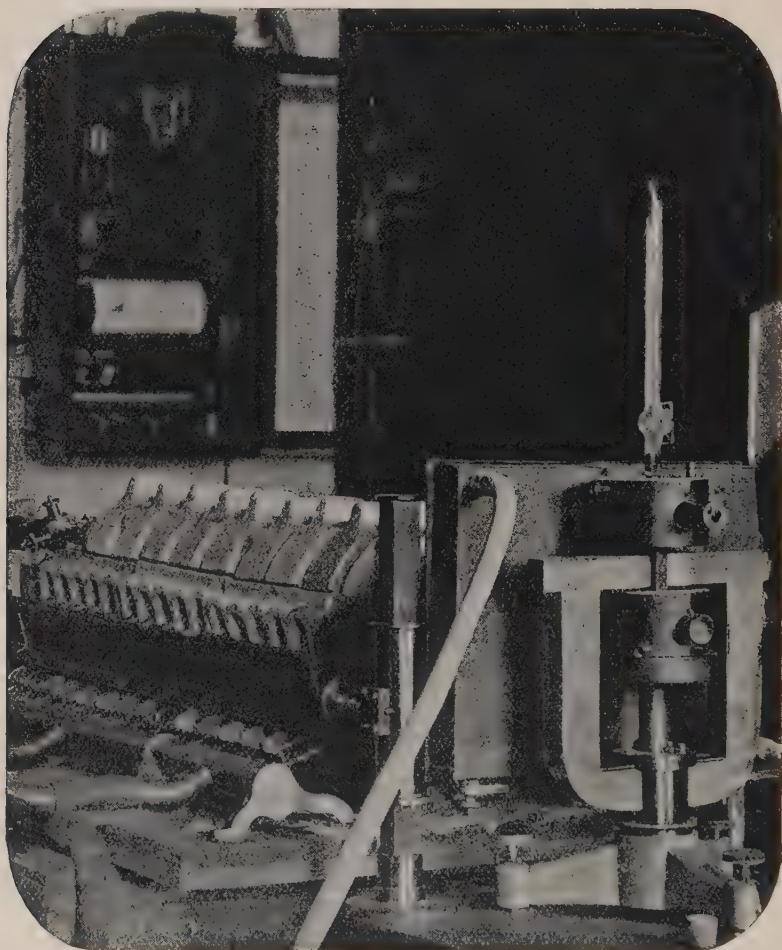
To make an observation the tube was heated to as high a temperature as the furnace was capable of, and when a steady temperature had been obtained, the amount of radiant heat coming from the interior of the hot tube and passing into the aperture (B) of the radio-micrometer was adjusted by the micrometer screw until a balance was obtained with the radiation coming from the Sun through the aperture (A).

If ρ is the angular semi-diameter of the sun, its radiation outside of our atmosphere is $K \cdot \pi \sin^2 \rho$, where K is a constant depending on the sun's temperature.

Again, if α be the height of the slit through which the radiation from the hot tube reaches the radio-micrometer, and β its width, the radiation may with sufficient accuracy be expressed by $K\alpha\beta/d^2$. Assuming Stefan's law, the radiation of the sun outside our atmosphere is $a\theta^4\pi \sin^2 \rho$, θ being the effective temperature of the sun.

* Stefan, 'Sitzber. d. k. Akad. zu Wien,' vol. 79, 1879 (Abth. 2), p. 391; Boltzmann, 'Wied. Ann.,' vol. 22, 1884; M. Planck, 'Drude Ann.,' vol. 1, No. 1, 1900; Paschen, 'Wied. Ann.,' vols. 58, 60, 1896, 1897; Lummer and Pringsheim, 'Wied. Ann.,' vol. 63, 395, 1897.

The percentage transmitted is p , therefore the radiation before reflection from the heliostat is $\frac{ap\theta^4}{100} \pi \sin^2 \rho$.



At reflection q per cent. is transmitted, therefore the radiation received by the radio-micrometer is

$$a \cdot \frac{pq\theta^4}{(100)^2} \cdot \pi \sin^2 \rho \quad \dots\dots\dots (1).$$

Also the radiation received from the hot tube is

$$a' (T^4 - T_0^4) \cdot \frac{\alpha\beta}{d^2} \quad \dots\dots\dots (2).$$

We need not inquire what is the absorptive power of the thermo-junction, provided that we are justified in assuming that lamp-black surfaces absorb the radiation from the hot tube as freely as that from the sun, or that the constants in these expressions (1) and (2) for the radiation may be taken to be equal.

On balancing, these expressions must be equal, and therefore

$$\begin{aligned} \frac{pq\theta^4}{(100)^2} \cdot \pi \sin^2 \rho &= (T^4 - T_0^4) \frac{\alpha\beta}{d^2} \\ &= T^4 \left(1 - \left(\frac{T_0}{T} \right)^4 \right) \frac{\alpha\beta}{d^2} \dots\dots\dots (3). \end{aligned}$$

But $\left(\frac{T_0}{T}\right)^4$ may be neglected, hence we have finally

$$\begin{aligned} \theta^4 &= \frac{\alpha}{\pi d^2} \cdot \frac{\beta}{\sin^2 \rho} \cdot \frac{100}{p} \cdot \frac{100}{q} \cdot T^4 \\ \text{or } \theta &= \sqrt[4]{\frac{10000 \alpha}{\pi d^2}} \cdot \sqrt[4]{\frac{\beta}{pq \sin^2 \rho}} \cdot T \\ &= \frac{0.13806}{\sqrt{\sin \rho}} \cdot \sqrt[4]{\frac{\beta}{pq}} \cdot T. \end{aligned}$$

The mean value of $\frac{0.13806}{\sqrt{\sin \rho}}$ is [1.30413].

Therefore
$$\theta = 1.30413 \cdot \sqrt[4]{\frac{\beta}{pq}} \cdot T \dots\dots\dots (4).$$

After a series of observations had been made, the furnace and tube were raised so that the radiation of the latter then passed into the aperture (A), on which the sunlight had previously fallen, while the beam of sunlight was now directed so as to be upon (B), and in this position a second series of observations was taken. The geometrical mean of the result of the two groups gives the Effective Temperature of the Sun, the effect of any difference in the sensitiveness of the thermo-junctions disappearing in the geometrical mean.

Observations were made in the manner described above on August 19th and September 30th, 1901, and reduced by means of equation (4), as exhibited in the following tables. In these the successive columns contain (1) the local mean time, (2) the value of β as read on the micrometer head, (3) the absolute temperature of the tube in the furnace, (4) the sun's altitude, (5) the percentage of the sun's radiation transmitted through the earth's atmosphere, (6) the angle of incidence on the heliostat mirror, (7) the percentage reflected from the surface of the mirror, (8) the corresponding value of θ deduced from equation (4). Of these (5) and (6) and (7) were determined as in Wilson and Gray's memoir referred to above.

Noté, $\alpha = 7$ mm.

Local time.	Balance.		Per cent. trans.	Angle of incidence.	Per cent. reflected.	Temp. absolute. $\odot$	Date, August 19, 1901. Blue sky.
	Reading.	Temp. absolute.					
h. m. 11 0 11 3 11 7 11 19 11 22 11 28 11 30 11 33 11 36 11 38	1.68	1099	66	62	9	5586	First Position (B).
	1.69	1098	66	62	9	5589	"
	1.70	1098	66	62	9	5598	"
	1.60	1100	66	62	9	5503	"
	1.55	1100	66	62	9	5459	"
	1.62	1101	66	63	11	5161	"
	1.70	1101	66	64	12	5223	"
	1.75	1101	66	64	12	5262	"
	1.77	1101	67	64	12	5278	"
	1.80	1101	67	64	12	5286	"
			Mean			5394	"
12 48 12 51 12 53 12 56 12 58 1 3 1 5 1 7 1 9 1 11	3.99	1119	67	68	15	6192	Reversed Position (A).
	4.00	1119	67	68	15	6184	"
	3.98	1119	67	68	15	6186	"
	3.96	1119	67	68	15	6190	"
	3.98	1119	66	68	15	6210	"
	3.94	1119	66	68	15	6193	"
	3.93	1119	66	68	15	6190	"
	3.93	1119	66	68	15	6190	"
	3.92	1119	66	68	15	6186	"
	3.96	1119	66	68	15	6202	"
			Mean			6192	"

Geometrical mean of A and B = $\sqrt{5394 \times 6192} = 5779^\circ$.

Note, $\alpha = 5$ mm.

Local time.	Balance.		Altitude.	Per cent. trans.	Angle of incidence.	Per cent. reflective.	☉ Temp. absolute.	Date, Sept. 30, 1901. Weather, slight haze.
	Reading.	Temp. absolute.						
h. m.								
10 45	2.05	1107	31 30	59	64	11	5318	First Position (B).
10 52	2.16	1112	32 0	59	64	11	5379	"
10 55	2.17	1113	32 0	60	64	11	5364	"
11 25	2.55	1124	33 0	61	66	12	5446	"
11 38	2.42	1124	33 0	61	67	13	5320	"
						Mean.....	5365	
11 51	5.20	1127	33 0	61	68	14	6302	Reversed Position (A).
11 55	6.05	1127	33 0	61	68	14	6585	"
12 0	6.02	1126	33 0	61	68	14	6570	"
12 8	5.39	1127	33 0	61	69	15	6290	"
12 18	5.67	1128	32 30	60	70	17	6201	"
12 25	5.18	1126	32 30	60	70	17	6053	"
12 32	5.25	1127	32 15	60	71	18	5992	"
12 36	5.18	1126	32 0	60	71	18	5968	"
12 50	5.55	1122	32 0	60	71	18	6050	"
12 58	5.25	1122	31 30	59	71	18	5992	"
						Mean.....	6201	

Geometrical mean of A and B = $\sqrt{6365 \times 6201} = 5768^\circ$.

In the above tables Rosetti's determination of the amount of the terrestrial atmospheric absorption has been used. It may be well, however, to give the results obtained by using other estimates of this quantity. Taking Langley's transmission coefficient when the sun is in the zenith as 59 per cent., compared to Rosetti's 71 per cent., the temperature would be multiplied by $\sqrt[4]{(71/59)}$ and thus become 5773×1.054 , which is 6085° absolute. And, as in the previous memoir, to make the case general, if any later investigation shows the zenith transmission coefficient to be x per cent., the effective absolute temperature becomes

$$5773^\circ \times \sqrt[4]{(71/x)}.$$

It may also be of interest to see what effect is produced if absorption in the atmosphere of the sun itself is taken into account. First, considering the falling off in radiation from the central to the peripheral parts of the sun's disc, we may deduce that, if the absorption were everywhere equal to that at the centre, the radiation would be multiplied by $4/3$ and the temperature would become

$$5773^\circ \times \sqrt[4]{(4/3)} = 5773 \times 1.074 = 6201^\circ.$$

Secondly, assuming Wilson and Rambaut's* result for the total loss due to absorption in the solar atmosphere as equal to one-third, our estimate of the temperature would have to be multiplied by $\sqrt[4]{(3/2)}$, and we get finally

$$6201^\circ \times \sqrt[4]{(3/2)} = 6201^\circ \times 1.107 = 6863^\circ \text{ absolute} = 6590^\circ \text{ C.}$$

I wish to express my thanks to Dr. Rambaut for some valuable suggestions during the progress of the work.

"The Chemical Origins of the Lines in Nova Persei." By Sir NORMAN LOCKYER, K.C.B., F.R.S. Received December 23, 1901,—Read January 30, 1902.

In the first two papers† which I communicated to the Royal Society on the observations of Nova Persei at Kensington, a general description of the spectrum in its earliest stages was given, and also a statement as to the probable origins of some of the strongest lines, depending upon a comparison of the Nova Spectrum with those of α Cygni, α Canis Majoris, γ Orionis, &c.

A table showing the results of the detailed reduction and discussion

* "The Absorption of Heat in the Solar Atmosphere," 'Proceedings Royal Irish Academy,' 1892, vol. 2, No. 2.

† 'Roy. Soc. Proc.,' vol. 68, p. 119 and p. 142.

Comparison Table of Bright Lines in the Spectra of Nova Persei and Nova Aurigæ with α Cygni Lines, Chromospheric Lines, and the Enhanced Lines of some of the Metals

Nova Persei (Kensington).		Nova Aurigæ.		α Cygni.	Chromo- sphere (1898 Eclipse).	Enhanced lines.		Remarks.
λ of middle of line.	Description of line.	Campbell.	Vogel.			λ .	Sub- stance.	
3836	Very broad, weak	—	3835	—	3835·6	—	—	H γ .
3889	Very broad. ? Narrow reversal in centre	—	3889	3883·1	3889·1	—	—	H ϵ .
3934	Broad, rather weak. Fine narrow reversal in centre	—	3934	3933·8	3933·83	3933·83	pCa	K (Ca).
3969	Very broad and fairly strong; shows fine narrow reversal in position of H (Ca) and possibly another weaker one in position of H ϵ	—	3969	{ 3968·6 3970·2	{ 3968·63 3970·25	3968·63	pCa	H (Ca) + H ϵ .
3982	All these are very weak diffuse lines which can just be seen with the unaided eye, but which will not bear any mag- nification, and their wave- lengths can only be roughly determined	—	—	4002·7	—	4002·77	pFe	
4003		—	—	4028·5	4028·5	4028·50	pTi	
4019		—	—	4067·3	4067·3	4067·30	pNi	Strongest enhanced line of Ni.
4029		—	4067					
4067								
4102	Broad and strong	4082 4095 4102 4108	—	4077·9	4077·9	4077·88	pSr	
			4102	4101·8	4101·9	—	—	H δ .

Comparison Table—continued.

Nova Persei (Kensington).		Nova Aurigæ.		α Cygni.	Chromo- sphere (1898 Eclipse).	Enhanced lines.		Remarks.
λ of middle of line.	Description of line.	Campbell.	Vogel.			λ .	Sub- stance.	
4128	Very broad and merging into H δ	4126	4125	$\left\{ \begin{array}{l} 4128 \cdot 1 \\ 4131 \cdot 1 \end{array} \right\}$	—	$\left\{ \begin{array}{l} 4128 \cdot 1 \\ 4131 \cdot 1 \end{array} \right\}$	pSi	
4175	Broad and fairly strong	4166 4180 4209 4227 4236 4246	4158 4176	$\left\{ \begin{array}{l} 4163 \cdot 8 \\ 4173 \cdot 5 \\ 4179 \cdot 0 \end{array} \right\}$	$\left\{ \begin{array}{l} 4163 \cdot 8 \\ 4173 \cdot 5 \\ 4179 \cdot 0 \end{array} \right\}$	$\left\{ \begin{array}{l} 4163 \cdot 82 \\ 4173 \cdot 52 \\ 4178 \cdot 95 \end{array} \right\}$	pSi pTi pFe pFe	Mean λ of enhanced double = 4176·23.
4232	Broad, but not very strong		4230	4233·3	4233·3	4233·25	pFe	
4247	Comparatively narrow, but merging into the broader 4232 line, slightly stronger than the latter		—	4247·2	4247·0	4247·00	pSc	Strongest spark line of Sc.
4262	Narrow, but fairly strong	4267	4262 4288	$\left\{ \begin{array}{l} 4262 \cdot 2 \\ 4290 \cdot 4 \end{array} \right\}$	—	$\left\{ \begin{array}{l} 4262 \cdot 15 \\ 4290 \cdot 38 \end{array} \right\}$	pCr pTi	
4300	Broad line, fairly strong	4296	—	$\left\{ \begin{array}{l} 4296 \cdot 7 \\ 4300 \cdot 2 \\ 4303 \cdot 3 \end{array} \right\}$	$\left\{ \begin{array}{l} 4296 \cdot 7 \\ 4300 \cdot 2 \\ 4303 \cdot 0 \end{array} \right\}$	$\left\{ \begin{array}{l} 4296 \cdot 65 \\ 4300 \cdot 21 \\ 4303 \cdot 34 \end{array} \right\}$	pFe pTi pFe	Mean λ of enhanced Fe double = 4300.
4314	Comparatively narrow, merging into 4300	4316	4315	4315·1	$\left\{ \begin{array}{l} 4314 \cdot 0 \\ 4315 \cdot 1 \end{array} \right\}$	4315·14	pTi	Possibly due to Sc 4314·25, one of the strongest spark lines.
4341	Broad and very strong. Doubt- ful reversal in centre	$\left\{ \begin{array}{l} 4331 \cdot 3 \\ 4340 \cdot 6 \\ 4347 \cdot 8 \end{array} \right\}$ 4355 4375 4385	4341	4340·7	4340·7	—	—	H γ .
			—	—	4355			
			—	4374·9	4374·9	4374·90	pTi	
			4383	4385·5	4385·5	4385·55	pFe	

Comparison Table—continued.

Nova Persei (Kensington).		Nova Aurigæ.		α Cygni.	Chromo- sphere (1898 Eclipse).	Enhanced lines.		Remarks.
λ of middle of line.	Description of line.	Campbell.	Vogel.			λ .	Sub- stance.	
4924	Broad and strong.....	{ 4913 4923 4929 4969 }	{ 4923 4925 }	4924.1	4924.1	4924.11	pFe	
5019	" "	{ 5007 5018 5095 5142 }	5016	5018.6	5018.6	5018.63	pFe	
5169	Broad and very strong.....	{ 5159 5169 5176 5200 }	5167	5169.1	5169.1	5169.07 5169.22 }	pFe	Certainly not the <i>b</i> - group of magne- sium.
*5224	Narrow and weak.	5234	523	—	5234.8			
*5273	" "	{ 5276 5285 }	528	—	{ 5275.1 to 5276.2 }	5276.17	pFe	
5316	Moderately broad and strong....	{ 5318 5329 5379 }	5317	5316.8	5316.8	5316.79	pFe	
*5420	Weak and rather narrow.	5454						
*5475	Weak and narrow.							
*5530	Fairly strong and broad.....	5535	—	—	5527.6	5527.03	pSc	By far the strongest spark line of Sc in the visual region.

of the bright lines in the best spectrum typical of the Nova in this early stage (that obtained with the 6-inch objective prism on February 25, when the star was nearly as bright as Capella), was undertaken later for inclusion in a general summary of the observations in course of preparation.

As various conclusions as to the chemical origin of some of the Nova lines have recently been published which differ widely from those arrived at from a careful study of the Kensington photographs, I think it desirable to publish the above-mentioned table at once. A detailed statement of the evidence on which these conclusions as to origin are based, will follow in the general summary before referred to.

That many of the stronger lines in the early spectra of Nova Aurigæ were chromospheric, has been pointed out by several observers, and all agree that there is little difference in the general aspect of the spectrum of Nova Aurigæ and that of Nova Persei at a corresponding stage of development. In confirmation of this it may be said that by means of direct comparison of the various Kensington photographs, the identity of most of the strong bright Nova bands with lines of α Cygni and the chromosphere—already known to be due to enhanced lines of certain metals—has been established.

With regard to the stellar relations of the Nova, I may state that in my note of February 28,* the agreement in position of its lines with those of α Cygni was pointed out. Later, Mr. McClean† confirmed this, and further stated that the bright lines of η Argus corresponded with the dark lines of the Nova; while later still, Sir David Gill‡ has shown the similarity between the spectra of η Argus and Nova Aurigæ. Hence we are led to the conclusion that the temperatures reached in the outbursts of both these Novæ were not greatly different from those of the stars named, and that in η Argus there are constant conditions which are similar to those temporary conditions which produce the appearance of Novæ.

In the table the lines of Nova Persei are compared with those recorded by Campbell§ and Vogel|| in Nova Aurigæ.

The probably corresponding lines of α Cygni, chromospheric lines, and enhanced lines, are also given in separate columns.

The reduction to wave-lengths and discussion of the lines in relation to those of other celestial and terrestrial spectra, has been undertaken by Mr. F. E. Baxandall, to whom my best thanks are due.

* 'Roy. Soc. Proc.,' vol. 68, p. 121.

† 'M.N., R.A.S.,' vol. 61, p. 387.

‡ 'Roy. Soc. Proc.,' vol. 68, p. 457.

§ 'Ast. and Ast. Phys.,' vol. 11, p. 808.

|| 'Ast. and Ast. Phys.,' vol. 12, p. 912.

“On some Phenomena which suggest a Short Period of Solar and Meteorological Changes.” By Sir NORMAN LOCKYER, K.C.B., F.R.S., and WILLIAM J. S. LOCKYER, M.A., Ph.D., F.R.A.S.
Received June 14,—Read June 19, 1902.

In continuation of the inquiries referred to in a former paper on Indian rainfall and solar activity,* attention has more recently been devoted to an examination of the variations of pressure over the Indian and other areas.

1. It is well known that in India during the summer months (April to September) and during the winter months (October to March) low and high pressures respectively prevail. In the case of the latter, the pressure is found to exhibit very remarkable and definite variations, and is in excess, every $3\frac{1}{2}$ years, on the average, while at these times of excess of high pressure the low pressure during the other 6 months of the year is deficient; so that every $3\frac{1}{2}$ years or so the high pressure becomes higher and the low pressure is not so low as usual.

2. Further, this short-period variation, which appears in the mean variation of pressure over the whole of India, is as well defined in the mean values for individual stations, such as Bombay (fig. 1, Curve F), Calcutta, Madras, Nagpur, &c.

3. The view that the variation of pressure in question over India and its neighbourhood is not due to local causes, but is produced by some external or extra-terrestrial action, is considerably strengthened by an examination of the pressure-curve of a very distant station, such as Cordoba. Dealing with the pressure of Cordoba during the high-pressure months, April to September, the curve (fig. 2, Curves F and E), representing the variation from the mean from year to year, is exactly the *inverse* of the curve representing the Bombay and other Indian pressures for the same months over the same period of time. The cause, therefore, which raises the mean value for the low-pressure months over the Indian area would appear to lower the mean value of high-pressure months at Cordoba simultaneously. In fact, we have a see-saw.

* ‘Roy. Soc. Proc.’ vol. 67, p. 409.

4. Further investigation shows that not only do the pressures of practically the whole Indian area exhibit variations from year to year, which present very similar features, but that this is the case with

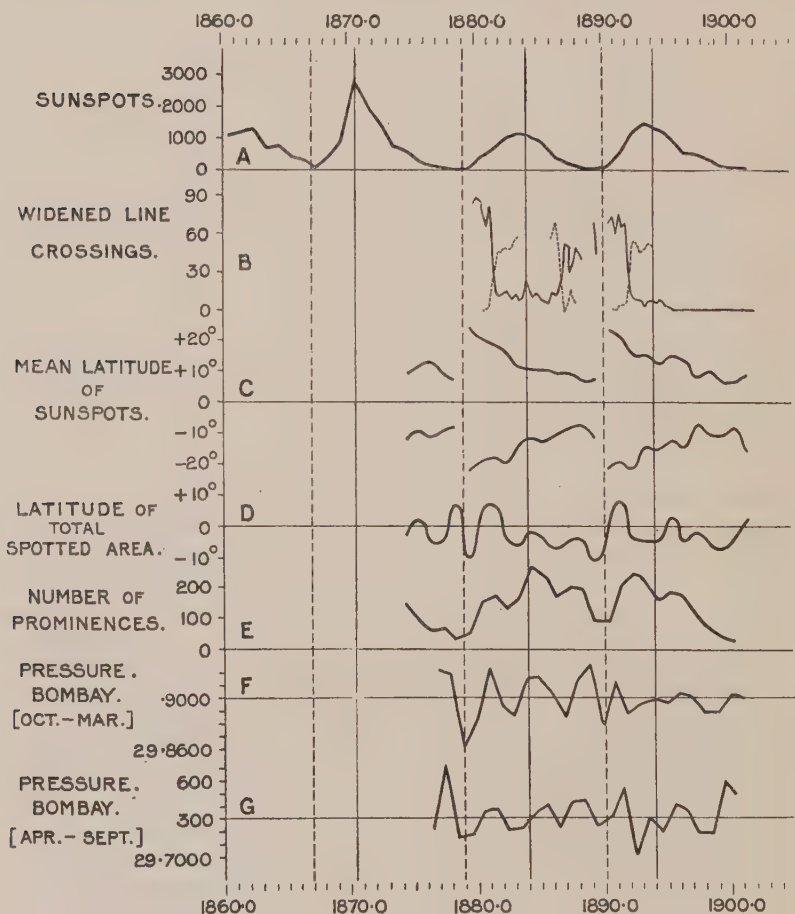


FIG. 1.

other large areas. Thus, for instance, it is found that the yearly mean pressures for Brussels, Bremen, Oxford, Valencia, and Aberdeen (the only pressures that have been at present examined) are all remarkably similar in their variations from year to year, and it might almost be said that one curve, representing the variations from the normal, would approximately define the pressures at all these places.

The probable extra-terrestrial origin of these short-period variations led to a detailed examination of the records of the phenomena con

nected with solar spots and prominences, with a view of seeing whether similar variations, indicating changes in the solar activity, could be detected.

5. A preliminary reduction of the Italian observations of prominences observed on the sun's limb since 1871 was first undertaken.

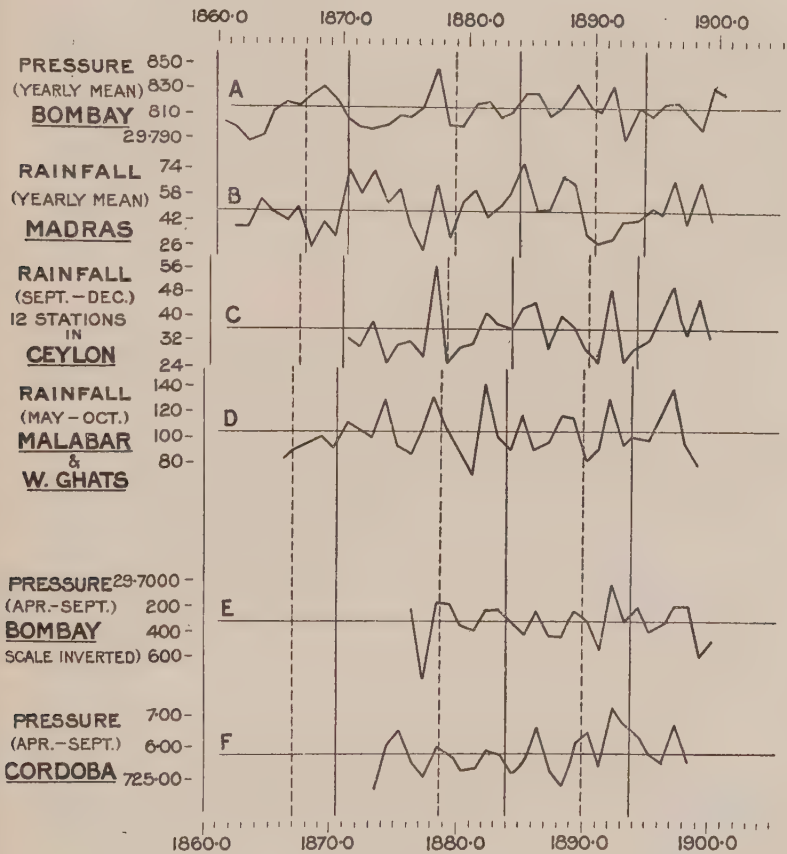


FIG. 2.

The result of this inquiry indicates that, in addition to the main epochs of maximum and minimum of prominences, which coincide in time with those of maximum and minimum of the total spotted area, there are prominent subsidiary maxima and minima having a similar short period and also coinciding in time. (Fig. 1, Curve E.)

6. Although these subsidiary prominence pulses are not distinctly duplicated in the curve representing the spotted area of the solar surface, it is to be noted that corresponding pulses are indicated in

the curves which represent the change of latitude of spotted area from year to year; and in each case an increase in prominence activity is associated with a decrease of latitude of the spotted area. (Fig. 1, Curves C and D.)

7. A comparison of these solar data with those already referred to relating to terrestrial pressures suggests that these simultaneous outbursts of prominences and changes of the latitudes in which the spots occur about every $3\frac{1}{2}$ years are the true cause of the pressure changes; and that the varying intensity of solar activity during the sunspot period of 11 years produces an effect on the pressure and circulation of our atmosphere, thus affecting the whole globe meteorologically.

8. The close correspondence between the epochs of these subsidiary pressure variations and those representing prominence frequency, suggests not only their very close relationship, but that the terrestrial pressure quickly answers to the solar changes, while so far as the work has gone it would appear that rainfall (fig. 2, Curves A, B, C, D) and snowfall are subsequent effects.

9. It may be remarked that we have already obtained evidence showing that this short-period variation is not the only one acting, but that the 11-year and 35-year periods apparently influence the short-period variations; but even this does not explain some anomalies already met with, and should the solar origin of these short-period pressure changes be subsequently confirmed, some of them not constant in all localities will have to be explained; and it is possible we may obtain in this way some new knowledge on the atmospheric circulation.

10. The period of time included in this survey begins generally with the establishment of the full records of the Indian Meteorological Department in 1875 and extends to 1895, when the regularity of the widened-line phenomena was broken, as stated in a previous communication.

ADDENDUM. Dated June 26.

In continuing the above researches we have plotted the percentage frequency of the solar prominences derived from the Italian observations for each 10° of solar latitude N. and S. of the Equator.

We find that the epochs of maximum prominence disturbance in the higher latitudes are widely different from those near the Equator. The latter are closely associated with the epochs of maximum spotted area; the former occur both N. and S. at intervening times.

We have then two sets of strongly marked prominence outbursts occurring at intervals of between 3 and 4 years.

Both sets are represented closely in the Indian pressure curves.

LIST OF WORKS
PRESENTED TO THE SOCIETY,
AND OF
WORKS PURCHASED WITH THE TURNOR
AND HORROX FUND,

JUNE 1901 TO JUNE 1902.

An asterisk () indicates that the work is an excerpt.*

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(*Observatory.*) fol. Adelaide, 1901

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